

Appendix 1

Table A1.1. List of stakeholders who participated in the scenario workshops. The table lists the names of stakeholder organizations that participated in the three rounds of workshops. With few exceptions, each stakeholder was represented by one senior staff member. Only few of these representatives were replaced across workshop rounds due to personnel turnover.

S.no.	Name of stakeholders	Administration level	Types of stakeholders	Sector
1.	Oromia Forest and Wildlife Enterprise	Zone	Government	Biodiversity
2.	Jimma University		Government academic institution	Both sectors
3.	Agriculture and Natural Resource	Zone	Government	Both sectors
4.	Land and Environmental Protection	Zone	Government	Both sectors
5.	Disaster Prevention and Preparedness Commission	Zone	Government	Food security
6.	Irrigation Development Authority	Zone	Government	Food security
7.	Women and Children's Affairs	Zone	Government	Food security
8.	Oromia Forest and Wildlife Enterprise	Woreda	Government	Biodiversity
9.	Agriculture and Natural Resource	Woreda	Government	Both sectors
10.	Land and Environmental Protection	Woreda	Government	Both sectors
11.	Disaster Prevention and Preparedness Commission	Woreda	Government	Food security
12.	Irrigation Development Authority	Woreda	Government	Food security
13.	Women and Children's Affairs	Woreda	Government	Food security
14.	Livestock and Fisheries Development	Woreda	Government	Food security
15.	Health Office	Woreda	Government	Food security
16.	Cooperative Promotion Agency	Woreda	Government	Food security
17.	Trade and Market Development	Woreda	Government	Food security
18.	Japan International Cooperation Agency (JICA)	Woreda	Non-Governmental Organization	Both sectors
19.	Finance and Economic Development	Woreda	Government	Food security

20.	Administration office	Woreda	Government	Food security
21.	Micro and Small Enterprise Development Agency (IMX)	Woreda	Government	Food security
22.	Administration and Security Office	Woreda	Government	Food security
23.	Oromia Credit and Finance Share Company (WALQO)	Woreda	Government	Food security
24.	Rural Road Authority	Woreda	Government	Food security
25.	Arga Multi-purpose Farmers Union	Woreda	Community-based Union	Both sectors
26.	Female farmers group	Kebele	Government	Both sectors
27.	Agricultural and Natural Resources Development Agents (Development Agents)	Kebele	Government	Both sectors
28.	Health Extension	Kebele	Government	Both sectors
29.	Religious leaders	Kebele	Community	Both sectors
30.	Kebele leaders (municipal leaders)	Kebele	Government	Both sectors
31.	Jawi Multi-purpose Cooperative	Kebele	Community-based cooperative	Both sectors
32.	Male farmers group	Kebele	Community	Both sectors
33.	Community Network Leaders (Gare Leaders)	Kebele	Community	Both sectors
34.	Land and Environmental Protection Development Agent	Kebele	Government	Both sectors
35.	Elementary school teachers	Kebele	Government	Both sectors

Table A1.2. Key features of the four scenarios.

Feature	Gain over grain: local cash crops	Mining Green gold: coffee investors	Coffee and conservation: a biosphere reserve	Food first: intensive farming and forest protection
Connectedness (outside landscape)	High to national market	High to global market	Medium- to global and national green institutions	High to national market
Main governance mechanism	Smallholder commercialization (national market)	Market based economy via import substitution and export promotion (global market)	Smallholder sovereignty and green economy (bottom-up participatory)	Smallholder intensification and regional market integration with state intervention
Main actors	Local community, merchants, extension agents.	domestic as well as foreign investors with big capital	Community-based institutions, green-build ngos, extension workers	Input marketing companies, cooperatives
Maintaining feedbacks	Commercialization, and profits	Economies of scale, profit and efficiency	Improved natural capital, values	Intensification, modernization and profit
Strengths	Improved living standards, infrastructure and public services	National export earning, , infrastructural and service development, employment	Sustainable development, resilience, and social justice	Improved food supply, smallholders income, forest protection
Weaknesses	Inequality, market dependence Rice fluctuation, mono-cropping and less resilience	Low resilience to market fluctuations and climate change, decreased social and natural capitals	Slow economic growth	Loss of natural capital, lack of resilience, lack of food diversity

Table A1.3. Description of the main drivers of change included in the causal loop diagram

Sno	Name of drivers of change	Description
1.	Infrastructure	Improvement in the roads, health services, schools
2.	Regional to the international market	Integration of local people to the regional and global market through the export of commodities produced in the landscape
3.	Farmers specialization and commercialization	Increased specialization of farmers into few marketable crops, and the decision of farmers to increasingly integrate into to market system through purchases of inputs and sale of commercial crops.
4.	Market dependencies and uncertainties	The increasing dependence of market by farmers to purchase inputs and sell products, and also uncertainty in the market price. Variables such as input and output market fluctuation, price volatility and thin and missing markets are categorized under this driver of change
5.	Labor market development	Increased access to educated human resources, increased employment opportunity are included under this driver
6.	Cooperative functions	Expansion of farmers cooperatives, expansion of financial services such as microfinance, and small and micro enterprises
7.	Farmer training	Improved regular training to farmers, and expansion of Farmers Training Centers
8.	Natural resource management	Conservation of biodiversity, soil and water conservation, and forest protection variables were coded under these drivers of change
9.	Land tenure	Improved security of land ownership, the right not to be evicted from own land, increased access and control over farmland were among the variables coded under this driver of change
10.	Coffee investors	Increased in the number of private companies (both domestic and international) investing in commercial coffee production in the landscape
11.	Natural capital farmland	Improved conservation of farmland biodiversity, quality of farmland natural resources including farmland productivity
12.	Natural capital forest	Improved conservation of forestland biodiversity, quality of forest in terms of species richness and diversity
13.	Crop raiding	Increased harmful wild animals, strengthened policy of ban hunting, increased crop loss by wild animals

14.	Modernizing and high external input farming	Increased intensification of the farm, increased use of inorganic fertilizers and agrochemicals, mechanization of farmland were considered under these drivers of change
15.	Income	Increased income from commercialization of cash crops (coffee, eucalyptus, khat) and food crops (maize, sorghum, and teff)
16.	Cash crops yield	Increased production and yield of cash crops (coffee, eucalyptus, khat)
17.	Food crops yield	Increased production and yield of cash crops (maize, sorghum, and teff)
18.	Food from the local market	Increased availability of food crops produced in other places, changes in diet to food purchased from the market than producing their food
19.	Climate change	Increased weather variability (rainfall pattern), increased long term change in climate elements, increased effects of climate change such as drought, and floods
20.	Grazing land and livestock	improved in grazing land, improved in access to communal grazing land, increased intensive livestock production,
21.	Crop and dietary diversity	Improved in the types of crops grown, improved in food diversity
22.	Public services and access	Increased access to market information, increased access to climate information, increased access to low-cost food
23.	Food security	Improved food production and availability, improved access to food, improved utilization of food, and improved uninterrupted supply of food
24.	Need to produce more food	Increasing the yield of food crops, the need to produce more food
25.	Agricultural land expansion	Increased agricultural area, expansion of farmland
26.	Land scarcity and conflict	Increased shortage of farmland, increased conflict between farmers and investors, increased conflict for access to resources
27.	Population growth and density	Increased population, increased fertility rate, increased number of people per unit area
28.	Migration and urbanization	Increased number of youth migrating to urban areas and outside the country (usually to Arab countries to work as a housemaid), increased number of jobless people in the nearby urban areas
29.	Family planning	Increased use of family planning

30.	Women's participation	Improved women's participation in household decision making, increased participation of women in community services and works
31.	Participatory resource governance	Increased community participation in resource management (forest and communal lands)
32.	Traditional management and life	Improved trust between communities, increased use of local informal institutions, increased participatory land management, improved cooperation between the communities.

Table A1.4. Main past drivers of change summarized based on their category

The major category of drivers of change in the past	Examples of past drivers of change under each category
Social and demographic changes	Local living conditions
	Social trust
	Traditions
	Population growth
	Education
	Food security
	Farmers awareness about the farming system
	Migration
	Health education and services
	Dietary diversity
	Individualism
	Family planning
	Agricultural training
	Youth cooperation
	Khat consumption
Underage marriage	
Religious understanding and expansion	
Mothers and child mortality	
Economic changes	Commercialization of crops
	Income and financial access
	Coffee and crop market
	Employment
	Market development and access
	Income from forest products
	Cooperative functioning
	Coffee investors
	Khat production
Microfinance programs	
Environmental changes	Land-use
	Forest cover
	Climate change
	Coffee productivity
	Food crop productivity
	Wildanimal population
	Soil quality and fertility
	Pollution
	Plantation of trees
Crop disease and insect pests	
Land use planning	

	Weather and Rainfall pattern
	Agricultural expansion
Technological changes	Modernized farming
	Phone network
	Roads and transport infrastructure
	Access to farm technologies and inputs
	Access to energy and power/electricity
	Agricultural research
	Access to social media and information
Political and governance changes	Gender equality
	Participation in decision-making
	Land-use rights
	Security and conflict
	Stakeholders plurality
	Corruption and nepotism
	Freedom of the community
	Political awareness and participation
	Rule and policy enforcement
	Below kebele community structures
Agricultural policy	

Appendix text A1.1. Full description of the scenarios

Gain over grain: local cash crops

Following international calls for agricultural development and national agricultural policy strategies, the Ethiopian government focuses on farmer commercialisation and specialisation as a pathway to increase economic returns and surplus production from smallholder agriculture. While in other parts of Ethiopia the focus is on food production, in the southwestern region farmers are encouraged to increase coffee production. Legal and environmental concerns prevent the government from also supporting other major cash crops, such as khat and fast-growing trees like *Eucalyptus*, but a lack of law enforcement and thriving markets have caused the expansion of these crops nevertheless. Actual crop choice often is rather opportunistic, and rapidly growing rural and urban populations further increase the demand for cash crops. Throughout the region, major investments have been made to improve road and railway infrastructure to allow market expansion and access.

The landscape now consists of large plots of intensively managed coffee forests interspersed with khat and tree plantations throughout the former farmland. The coffee forests are intensively managed, especially through regular clearing of undergrowth and heavy use of agrochemicals. While the coffee forests still provide some refuge to wild biodiversity, management practices have resulted in a stark loss of plant species and wildlife compared to the past. Khat plantations on former farmland are intensively managed as well. Tree plantations, most prominently monocultures of *Eucalyptus*, but also other fast-growing species such as *Grevillea* or *Cupressus*, are widespread, and in some places bamboo and native trees are also cultivated. The plantations of exotic species have severely impacted soil quality and lowered water tables in the landscape, which has made the area not only more susceptible to droughts but also made large areas unsuitable for agriculture. Farmland biodiversity has plummeted dramatically, because khat and tree plantations provide habitat to very few native species. Baboons and monkeys, however, still live in the forests and use farmland tree plantations for shelter; the animals' frequent raids of homegardens and small fields pose a serious problem to the remaining crops, especially for poor farmers who rely on their own food production.

Live fences in the farmland protect the valuable cash crops from theft or destruction. Very little space remains for cultivating cereal crops, and few farmers have maintained small fields or homegardens for cereals. These small parcels for gardening and cropping are vital for the poor, because their lack of land and economic resources has excluded them from the cash crop boom and has limited their access to forest ecosystem services.

Overall, households have benefited from increased incomes and higher (material) living standards – almost all houses now have metal sheet roofs. Infrastructure and public services have improved, more children complete secondary school, and the overall population is becoming more educated. While many people are driven to emigrate from the southwest due to the growing population, increased education and knowledge have decreased population growth rates. Imported food from outside the region is now available at relatively cheap prices. Overall food security is high and people’s diets now often include industrially processed foods including meat and dairy products. However, uncertainties remain in periods of drought and due to market price fluctuations. Social costs, in contrast, have been very high. There is a high degree of inequity, and poor people unable to seize cash crop opportunities are even poorer now. The increase in khat production also enhanced khat consumption leading to conflict, crime and a decline in community spirit. Theft of valuable cash crops is common, and there is a high degree of mistrust among the local community. The shift towards a cash-based society has led to the collapse of traditional institutions such as collaborative farming and guarding, and farmers now have to make large investments in human capital to manage and guard their cash crop plantations. Despite better health infrastructure, there are health problems caused by excessive khat consumption and the widespread use of pesticides, which affects food, air and freshwater quality.

Mining green gold: coffee investors

Ethiopia has shifted its focus towards large-scale commercial farming and the export of products to enhance agricultural development and national economic growth. Coffee is the primary export commodity. Due to climate change, there has been a global decline in the supply of coffee, and international demand and market prices for coffee have increased. Because of these conditions the government defined large-scale coffee production destined for the international market as the prime development priority for the region. Because the smallholder coffee production system is

fragmented and because smallholders lack capital and institutional support to produce coffee for export, large-scale investors are given priority. Smallholder, communal and forestland conducive for coffee investment have been transferred to capital investors for the expansion of large-scale intensive coffee plantations.

The landscape is largely transformed to a coffee production zone, with monocultures of high yielding improved coffee cultivars. Large areas of natural forests and farmland have been converted into intensively managed shade coffee plantations, often using non-native shade tree species. Forest biodiversity and ecosystem services have declined rapidly, and it is becoming increasingly difficult for local people to access important forest products. Large-scale forest degradation and hybridisation with the new coffee varieties have destroyed the wild gene pool of *Coffea arabica*. As intensified coffee plantations have expanded into farmland, very little land is left for crop production. Local farmers are left to farm marginalised areas unsuitable for large-scale coffee plantations such as on steep hills and in homegardens. Farmland biodiversity has decreased immensely as a result of the expansion of intensive coffee plantations. This has reduced smallholder farmer opportunities even further – for example, there are too few bees left for honey production. Furthermore, the increased use of agrochemicals for intensive coffee production and the expansion of coffee processing has led to polluted soils, groundwater, and rivers.

Due to the expansion of large-scale coffee plantations land has been transferred from local farmers to investors. Although farmers have been offered compensation for their farmland, this compensation has often been inadequate to make a living afterwards. Furthermore, community participation is tokenistic, and the investors do not live up to their initial promises of transferring skills, knowledge and technology to local communities. People's livelihoods have shifted from being subsistence-based towards employment as the major source of income. Employment opportunities mostly consist of daily labour at the coffee plantations. Job security is low, and often, jobs are given to non-locals. Infrastructure improvements have largely benefited investors, for example through better roads, while improvements in public services such as schools, health centres and other social services have been much more limited.

The transformation from semi-subsistence farming to large-scale coffee production has left many people landless, and vulnerable with little resilience to cope with shocks. The low wages received

from labour have increased poverty among the local population. Decreased living standards and loss of land are causing major conflicts between local people and investors. Food security is mainly ensured through what can be purchased from the market. The low financial capital of people reduces dietary diversity and food security. Land scarcity, a general lack of opportunities, and a growing population, cause mass emigration from the countryside to towns, cities and countries abroad. Overall, social capital is very low. Traditional farming culture has been lost, and the majority of people have no idea how to cope with the change in livelihoods and population growth other than by leaving the area.

Coffee and conservation: a biosphere reserve

Years of conventional intensification supported by the green revolution have degraded natural resources throughout Ethiopia. Reduced soil fertility, large-scale soil erosion and persistent droughts made it impossible to grow enough food to feed the Ethiopian population. Due to pressure from environmental NGOs and local resistance to the failing strategy of conventional agriculture, the government has transformed its agricultural policy towards sustainable land management. Biosphere reserves are being established across Ethiopia to mainstream approaches that integrate conservation of natural habitat and sustainable food production. This shift was facilitated by increasing international demand for sustainably produced agricultural products, as well as the active participation of locals in the transformation process. In the southwest, the *Buna Dhuga Biosphere Reserve* has been established. This reserve emphasises not only the traditional culture of growing and drinking coffee, but also good social relationships, which are the central pillar of the newly established community-based management of the reserve.

The landscape consists of a core zone of unused natural forest, a buffer zone for low-intensity production of local coffee, wild honey, and other forest products, and an outer area with a mosaic of cropland, pastures and tree plantations. Planting of native tree species for timber, firewood and shade for coffee, is highly encouraged, and care is taken that people retain their uses and knowledge of local plants. The land is farmed using a mixture of traditional agricultural practices and modern techniques such as crop rotation, intercropping with legumes, soil and water conservation, and composting. Livestock production and communal grazing are maintained and also provide manure for fertilising the fields. People grow a wide variety of fruit and vegetables in

their homegardens. Due to these sustainable practices, farmland biodiversity is recovering from earlier impacts of fertilisers and pesticides, and important ecosystem services provided by farmland, such as soil fertility, are restored.

The management of the biosphere reserve is realised through strong community participation, which also fostered the acceptance to establish a protected core zone of natural forests. Although some forest clearing was unavoidable to accommodate the growing population in the past, the core zone now is a haven for many rare and endangered species, and also is a refuge for the wild gene pool of *Coffea arabica*. To reduce negative impacts of wild crop-raiding animals, jobs as wildlife guards have been provided through community-based arrangements, especially to local people without access to land. The wildlife guards are responsible to help scare off crop-raiding animals, provide information to farmers on how to best protect fields, and where necessary reduce the populations of the most problematic species such as baboons and bush pigs via controlled culling measures. Community-based management of the reserve supports the continuation of semi-subsistence farming and provides job opportunities for landless or poor people and minorities.

Social capital is high, and traditional collaborative agreements, such as *didaro*, have received renewed attention and have facilitated the transition process. Conflicts are usually solved within the community. Cultural integrity remains high and people are in good spirit. As an important part of their cultural identity, people grow and eat the majority of their own food. In addition, coffee and nature-based tourism are beginning to develop, bringing in extra money. The majority of people are now able to live in houses with metal roofs, have access to health and education, and are able to buffer their livelihoods during difficult times. Women in the region are empowered through inclusion in decision-making processes. This has led to higher acceptance of family planning and smaller family sizes, reducing population growth in the long-term. Despite limited economic growth, equality among people is high, and diversified farming combined with high social capital increases household resilience to climate change and other potential problems, such as market fluctuations or crop diseases.

Food first: intensive farming and forest protection

Due to climate change, coffee production has shifted to higher altitudes, and growing coffee has become unviable in most parts of southwestern Ethiopia due to frequent outbreaks of coffee pests

and diseases. At the same time food production in the dryer parts of Ethiopia has seen a sharp decline due to increasingly frequent droughts. Given declining coffee production locally and stagnating food production in other parts of the country, the Ethiopian government declared the southwest a priority area for producing crops, fruit, vegetables, and beef. As a consequence, a rapid transition towards industrialised agriculture with high-yielding varieties and high agro-chemical input was realised. Modern agriculture almost completely replaced traditional small-scale farming and eroded local knowledge. The boost in land use intensity and efficiency required large-scale land consolidation, including the clearing of woody vegetation and cropland expansion. Flat areas including drained wetlands are now dominated by large cereal fields. The hills and steeper slopes are used for intensified fruit and vegetable production, commercial honey bee keeping and beef fattening. The transition of the farming system was facilitated by cooperatives that provided infrastructure for inputs, marketing and financial support. Farmers had to specialise and commercialise their production, now using large amounts of pesticides, artificial fertilisers, seeds and fodder. Local crops have been replaced by fast growing new varieties that require large amounts of pesticides and fertilisers. Farming has been mechanised as much as possible, with government-owned tractors being available for hire to work the larger stretches of cropland in the flat areas. The intensification of agriculture has led to a deterioration of natural capital in farmland, decreasing soil fertility even further, and hence increasing the dependence on external inputs and new crop varieties. Freshwater sources are polluted from agrochemicals. Virtually everything harvested is sold to markets. Storage facilities and processing plants have been set up in the larger towns.

To limit further expansion of farmland, to reduce potential impacts of climate change and to satisfy international pressure for nature protection, the remaining patches of natural forest are put under strict protection. The resulting protected areas have been partially fenced to limit illegal forest use but also to reduce crop raiding from wild animals. Despite strict protection, the fragmentation and isolation of remnant forest patches has led to further decreases in forest biodiversity. Large-scale deforestation combined with intensification of agriculture has led to widespread soil erosion, which the government now tries to tackle by building dams and water channels.

Large-scale land consolidation has increased overall inequality in the region, and left many people without access to land. While farmers who managed the transition and received land are relatively

well off, others remain poor. Some managed to get employment on other people's farms, but opportunities are limited because of high levels of mechanisation and a focus on efficiency. Other people have emigrated to towns in an attempt to make a living by working in one of the many food processing factories. With modernisation, individualistic behaviour has increased, and cultural identity and community cohesion have been eroded. People now mainly eat purchased and processed food, including processed meat and dairy products imported from elsewhere. Dietary diversity no longer comes from diversified cropping, but depends on what is available and affordable on the market. Due to specialisation and commercialisation, the resilience of farmers is primarily based on financial capital. However, due to crop specialisation and the loss of many ecosystem services, farmers are not resilient to climate change, and, despite increased financial capital, some are forced into debt after unfavourable years with low harvests. Moreover, people are strongly affected by market price fluctuations to sell harvests and buy food, which further decreases their resilience. Population growth remains high, particularly among the poor. Many of the poor emigrate to towns and cities, putting additional pressure on increasingly large urban slums.