Ethiopian soya bean and sunflower value chains

Opportunities and challenges

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This research has been carried out in the framework of the Policy Research Cluster International (BOCI) by commission of the Dutch Ministry of Economic Affairs, Agriculture and Innovation (EL&I). The study is executed in close cooperation with the Public-Private Partnership on Oilseeds in Ethiopia (PPPO).

Photo: Jo H.M. Wijnands/LEI

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Appendices

Acronyms

A	Actual yields to distinguish from BP best practice yields
BP	Best practice yields as alternative for actual yields
CSA	Central Statistical Agency of the Federal Democratic Republic of Ethiopia
DAP	Di-Ammonium Phosphate (1kg DAP contains 0.208kg P and 0.18kg N)
DRI	Dietary Reference Intake
E.C.	Ethiopian Calendar
ETB	Ethiopian Birr
EFA	Essential Fatty Acids
EFC	Ethiopian food Cooperation
EU	European Union
EUR	European Euro
FAO	Food and Agricultural Organisation
Fb	Faba beans
FFA	Free Fatty Acids
Fp	Field peas
FVO	Food and Veterinary Office (EU)
G.C.	Gregorian Calendar, widely used in the Western World
GDP	Gross Domestic Production
GVP	Gross Value of production
K	Potash, potassium (1kg K = 1.2kg K_2O)
Li	Linseed
Ma	Maize
N	Nitrogen
Ne	Neug
P	Phosphorus (1kg P = 2.29kg P_20_5)
PPP	Purchasing Power Parity
PPPO	Ethiopian-Dutch Public-Private Partnership on Oilseeds
QSAE	Quality and Standards Authority of Ethiopia
Se	Sesame seeds
Sg	Sorghum
So	Soya beans
SWOT	Strengths, Weaknesses, Opportunities, and Threats
Su	Sunflower seeds

Te	Teff
Wh	Wheat
Urea	1kg urea contains 0.46kg N
USA	United States of America
USD	United States dollar
VA	Value Added
WDI	World Development Indicators

Some keywords

Edible oil	In this report mainly used for plant seed oil for human consumption, plant seed oil is also called vegetal or vegetable oil
Neug	*Guizotia abyssinica* is an oilseed crop, indigenous to Ethiopia. Also called noug, niger seed or black birdseed
Vegetable	Products from plants. FAO use sometimes the word vegetal

Key Facts Ethiopia in 2009

Indicator	
Population in million	83
Population growth (annual %)	3
Rural population (% of total population)	83
Rural population growth (annual %)	2
Urban population (% of total)	16
Urban population growth (annual %)	4
GDP per capita, PPP (current international $)	936
GDP per capita (current US$)	345
GDP growth (annual %)	9
GDP per capita growth (annual %)	6
Inflation, consumer prices (annual %)	8
Employment in % of total in 2005 - Agriculture - Industry - Services	 80 7 13
Exchange rates 2007, July 1 2008, July 1 2009, July 1 2010, July 1	USD1=EUR0.64= ETB8.89 USD1= EUR0.63= ETB8.40 USD1= EUR0.61= ETB11.22 USD1= EUR0.82= ETB13.40
Ethiopian Calendar 2002	Gregorian Calendar September 2009 to August 2010
Source: WDI, exchange rates; www.oanda.com/currency/converter/	

Preface

Governments in developed and developing countries feel a need to improve food security and the economy by improving agricultural value chains. Governments can facilitate these developments, however private businesses have to be involved for implementing new or improved value chains. In this respect, fresh vegetable, cut flower, and oilseed value chains are in focus of the Ethiopian policy. This report analyses the business opportunities of soya beans and sunflowers. The opportunities are addressed to firms in all levels of the value chain ranging from consumers to farmers in the Ethiopian agriculture.

An interesting new feature of this study, compared to previous Wageningen UR reports on 'Oilseeds Business Opportunities in Ethiopia' (Wijnands et al., 2009) is the comparative quantifications of alternatives. Consumers may choose to buy domestic or imported products, processors can process oilseeds from different crops (either locally grown or imported) and farmers can choose to allocate inputs (land, labour, fertiliser) to different crops. Information on alternatives and on the production systems is essentially to assess the opportunities for a single crop.

The analytical framework is based on agronomics, economic optimisation, strategic management and on institutional economics. The approaches consider nutrient balances and crop rotation at farm level, use of oil cake for feed, edible oil processing efficiency, economic benefits, governance of value chains, as well as the impact of the institutions. The results show that lack of credits obstructs implementation of more advanced farming practice, even if the production and farm incomes double. Improved crop varieties will not be adapted if a farmer cannot buy e.g. the improved seed varieties, fertiliser or crop protection agents because of lacking credit facilities. The report is therefore relevant for all people who are interested in developing agriculture or agricultural value chains in Ethiopia and other developing countries

Reading suggestion
Each chapter presents at the beginning the 'Key findings' for a quick overview of the contents. The summary, the value chain analysis (Chapter 7), the discussion (Chapter 8), and the recommendations (Chapter 9) provide the main information for policymakers. The other chapters provide in-depth background information for the interested readers at the level of different chain links.

Prof Dr R.B.M. Huirne
Managing Director LEI

Acknowledgements and disclaimer

During the fact-finding missions in Ethiopia, the authors met numerous Ethiopian entrepreneurs, government officials, and representatives of non-profit and research organisations (see list below). Their cooperation contributed largely to this final report. We would like to thank them for their time, openness, and inspiring input.

We also thank the Agricultural Counsellor on the Embassy of the Kingdom of the Netherlands (EKN), in Ethiopia, Geert Westenbrink and Joep van den Broek from EKN and Public-Private Partnership on Oilseeds (PPPO) in Ethiopia for their support during the research. We appreciated exploiting the extensive knowledge on oil processing and experience of the Ethiopian oilseed industry of Jaap Biersteker from Biersteker Consultancy.

Finally, the authors thank Jote Wakjira Korssa from F&S BDS PLC for retrieving available information and interviewing the stakeholders. He also organised the stakeholder workshop on December 9, 2010. The workshop aimed at validating and discussing the preliminary results.

Consulted stakeholders		
name	**organisation**	**activity**
Ato Yonas Kumera	AISE	Input supply
Yonas Sahilu	ESE	Seed supply
Abdul jemal	KoonFeyKun PLC	Farming, export
Aba Zinab	Dimtu FMO	Farmers' Market Organisation
Yoseph Markos	Dym PLC	Export
Henok Tenna	Ashraf PLC	Farming, processing and trade
Jemal Ayalew	Warka PLC	Export
Ato Birhanu Mosissa	FAFFA	Food processor
Mustofa Said	Addis Mojo	Edible oil manufacturer
Dereje Begashaw, Seifu Sahilu	Adama Taiem	Edible oil manufacturer
Mebrat Ayale	Kezefa	Edible oil manufacturer
Yemane kebede, Fekadu Bedru	Kana	Edible oil manufacturer
Fasil Zegeye	Akaki Animal feeds Sc	Animal feed manufacturer
Fitsum Alemayehu	HARI	Research
Fekadu Gurmu	SARI, Hawasa	Research

Consulted stakeholders (continued)		
name	**organisation**	**activity**
Mr Abate Lemu	MoARD	Government
Dr Muse Yakob	EPOSPEA	Exporters' Association
Dr Abush Tesfaye	JARI	Research
Dereje Chanie	PPPO	PPPO
Matthias Olthaar	University of Groningen (NL)	Research
Assegid Asfaw	Alema Koudijs	Animal feed manufacturer
Meseret Asfaw	FFARM PLC	Consultancy
Dr Bulcha Woyssa	Holetta ARI	Research
Cor Jan Zee	Meset Consult	Consultancy
Ali Keddi	KoonFeyKun PLC	Farming, export

The statements, findings, interpretations, and conclusions expressed in this report are those of the authors. They do not necessarily reflect the views of the Dutch Ministry of Economic Affairs, Agriculture, and Innovation (EL&I), the Embassy of the Kingdom of the Netherlands in Ethiopia, Public-Private Partnership on Oilseeds in Ethiopia or the consulted stakeholders.

Summary

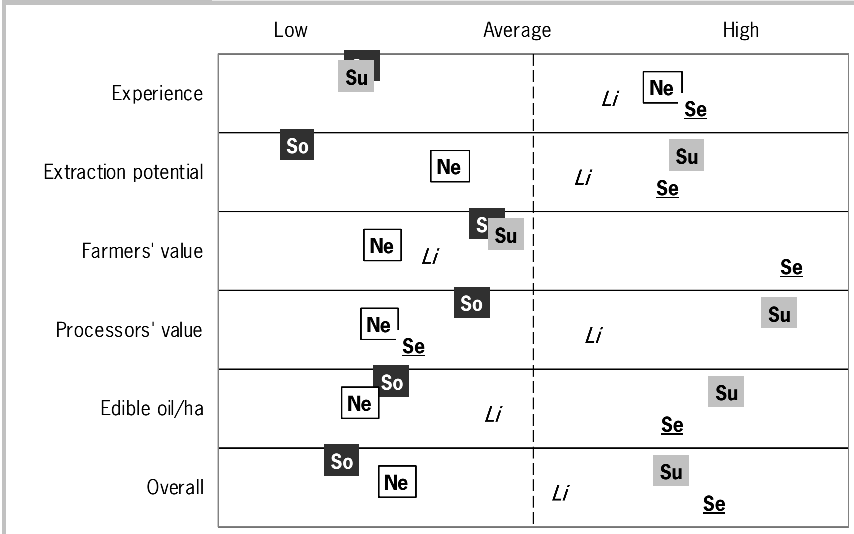
S.1 Key findings

Soya bean and sunflower value chains are economically feasible in Ethiopia.

Sunflowers have good opportunities, whereas soya beans have poor opportunities compared to other Ethiopian oil crops. (see sections 7.1 and 7.4)

The economic benefits at farm level are not significantly higher with these new crops than without them. Sunflower seeds processing results in higher operating surpluses than most other oilseeds. Processing soya beans results in comparable operating surpluses to the actual seeds.

Figure S.1 Attractiveness (z-scores) of oilseed value chains



Li=Linseed, Ne=Neug, Se=Sesame, So=Soya bean and Su=sunflower.

However, five issues must be addressed:
- Growers might be reluctant, because they have little experience with growing soya beans and sunflowers.

- The introduction of new crops demands a focused strategy, shared by all participants in the value chain.
- Uncertainties for early adopters need to be mitigated.
- A focus on sunflowers is preferable, since the Ethiopian menu is insufficient in fats and energy and is adequate in proteins.
- An analysis of opportunities for soya bean proteins in the livestock sector is also recommended.

S.2 Complementary findings

Best-practice yields offer huge opportunities.

The next 10 years, approximately 65% more food is required to satisfy the growing population and the increased consumption per head. In particular, a higher fat consumption per head is recommended because the average consumption is far below the Dietary Reference Intake (see chapter 3).

The Ethiopian agriculture production can be doubled if best-practice yields are realised, such as those that have already been realised on Ethiopian field trials. Sufficient capital and inputs are key success factors (see section 6.3). If best practices are implemented, the resulting higher production can be used either for the larger food demand, for processing more edible oil and by this substituting imports or for increasing the export of oilseeds. Lower imports of edible oil and higher exports of oil seeds will improve the trade balance. The potential of best-practice yields is huge, but this requires a strategy on how to exploit at least a part of it (see chapter 9).

The analytical approaches for different chain links help farmers, businesses and other actors in assessing opportunities in value chains. Using factual data of actors involved in the value chain will improve the reliability of the recommendations. Therefore, we recommend exploiting this framework of approaches for a specific target group in a specific region.

S.3 Methodology

The Dutch Ministry of Economy, Agriculture and Innovation has asked LEI to assess opportunities for soya beans and sunflowers at all levels of the value chain. From consumers to producers, integrated analyses of the edible oil industry have been applied, using agronomic, economic, strategic management and institutional approaches. The information and data are from existing databases and publications.

Samenvatting

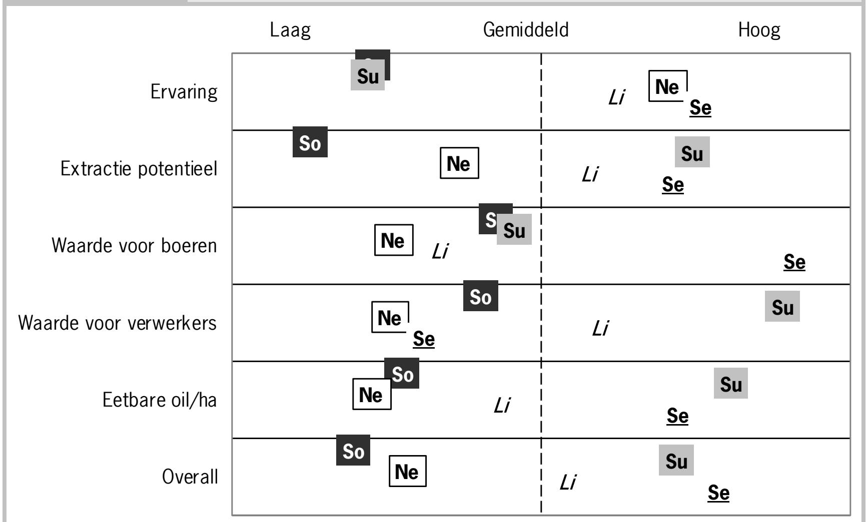
S.1 Belangrijkste uitkomsten

Sojabonen en zonnebloemenketens economisch en agronomisch haalbaar in Ethiopië.

Vergeleken met andere Ethiopische oliezaden hebben zonnebloemen goede en sojabonen matige mogelijkheden.

De economische voordelen op boerderijniveau zijn niet significant hoger met deze nieuwe gewassen dan zonder. Verwerking van zonnebloemen leidt tot hogere bedrijfsopbrengsten dan de meeste andere oliezaden. Verwerking van sojabonen leidt tot vergelijkbare bedrijfsopbrengsten als de huidige zaden.

Figuur S.1 Aantrekkelijkheid (z-scores) van oliezaden ketens



Li=Lijnzaad, Ne=Neug, Se=Sesamzaad, So=Sojabonen en Su=Zonnebloemen.

Er is echter een vijftal punten dat aandacht behoeft:
- Telers kunnen terughoudend zijn, omdat ze weinig ervaring hebben met het telen van sojabonen en zonnebloemen.
- De introductie van nieuwe gewassen vraagt om een strategische focus die wordt gedeeld door alle deelnemers in de waardeketen.

- Onzekerheden voor starters met deze nieuwe gewassen dienen afgezwakt te worden.
- Een focus op zonnebloemen verdient de voorkeur, omdat het Ethiopische dieet te weinig vet en voldoende eiwitten bevat.
- Een analyse van de mogelijkheden voor sojabonen en eiwitten in de veehouderij wordt aanbevolen.

S.2 Overige uitkomsten

'Best practice'-opbrengsten bieden gigantische mogelijkheden

De komende 10 jaar is er zo'n 65% meer voedsel nodig om te voldoen aan de behoefte van een groeiende bevolking en de toegenomen consumptie per hoofd. Vooral een hogere vetconsumptie wordt aanbevolen omdat de gemiddelde consumptie van vet beneden de Aanbevolen Dagelijkse Hoeveelheid ligt.

De Ethiopische landbouwproductie kan verdubbelen indien dezelfde 'best practice'-opbrengsten worden gerealiseerd als nu al worden gehaald in Ethiopische praktijkproeven. Voldoende financiële middelen en inputs zijn kritische succesfactoren. Indien 'best practices' worden ingevoerd, dan kunnen de resulterende hogere opbrengsten ofwel gebruikt worden voor de grotere vraag naar voedsel, ofwel voor de verwerking tot eetbare oliën in plaats van deze te importen, ofwel voor hogere exporten van oliezaden. Lagere importen van eetbare oliën of hogere exporten van oliezaden dragen bij aan een betere handelsbalans. De potentie van de 'best practice'-opbrengsten is gigantisch, mits er een strategie wordt toegepast waarbij ten minste een deel kan worden uitgebaat.

De analysebenadering voor de verschillende ketenschakels helpt boeren, bedrijven en andere actoren bij het bepalen van de kansen in de waardeketens. Door het gebruik van specifieke data van spelers in de waardeketen zal de betrouwbaarheid van de aanbevelingen toenemen. Daarom bevelen we aan om dit analysekader te gebruiken voor een specifieke doelgroep in een specifieke regio.

S.3 Methode

Het ministerie van Economische Zaken, Landbouw en Innovatie heeft het LEI gevraagd de kansen voor sojabonen en zonnebloemen in Ethiopië op alle niveaus van de waardeketen te bepalen. Van consumenten tot producenten zijn integrale analyses toegepast met gebruikmaking van benaderingen uit de agronomie, de economie, het strategisch management en de institutionele economie. De informatie en data zijn ontleend aan bestaande databanken en publicaties.

1 Introduction and research approach

Key findings

- This report provides insight into the agronomic and economic opportunities of cultivating and processing soya beans and sunflowers.
- The research framework uses economic, governance and institutional approaches.
- The opportunities to produce edible oil and protein in Ethiopia are analysed at all levels of the value chain.
- The methods are optimisation techniques and benchmarking opportunities against alternatives.

1.1 Aim and approach

Do soya beans and sunflowers offer opportunities for human consumption either as edible oil or as protein source in Ethiopia? Ethiopia is an exporter of oil seeds and at the same time an importer of edible oil for human consumption. The value of imported oil is 40 to 60% of the export earnings of oilseeds (Wijnands et al., 2009). Of the total domestic oil supply 65% is imported, mainly palm, soya bean and sunflower oil.

In the 'Growth and Transformation Plan 2010/11-2014/15', the Ethiopian government aims at a higher performance of the agriculture sector by 'the intensification of marketable farm products for domestic and export markets, and by small and large farmers. The commercialisation of smallholder farming will continue to be the major source of agricultural growth.' The agriculture sector will be transformed to a high growth path to ensure food security, to broaden export and to keep inflation low (MoFED, 2010). Developing new value chains based on soya beans and sunflower seeds can improve the performance of the entire edible oil chain in Ethiopia. Soya beans as well as sunflower seeds are cultivated in Ethiopia. However, each crop has a share below 1% of the total oilseed production. To assess the opportunities for Ethiopian soya beans and sunflower value chains, we will address the following topics:

1. In which agro-ecological zones in Ethiopia can these crops be cultivated?
2. How do these crops fit in the actual farm practice?

3. How do these crops fit in the value chain of edible oil? Or more specifically: Which products can be made from soya beans and sunflower seed? In addition, with which products do they compete?
4. What are the key success factors for the development of successful value chains for these two crops? This question needs to be answered from different viewpoints. Developing new value chains can be viable for the whole chain. However, oil-processing firms at different levels are mutually dependent and at each level, the new value chain should be viable and profitable. This requires formal and informal contractual agreements. Moreover, such governance agreements need to comply with the institutional environment e.g. the contract should be enforceable. Therefore, we will answer this question from an economic, strategic management, governance, and institutional viewpoint.

These aspects represent different levels of institutional analysis: from rational daily decisions to spontaneous behaviour embedded in traditions. Williamson (2000) distinguishes four levels of social analysis (Table 1.1). The highest (first) level in Williamson's framework is embedded in the culture of the country, and can hardly be influenced. Therefore, we will focus on the other 3 levels. The bottom (fourth) level states that the short-term economic conditions should be fulfilled. The third level deals with the governance or exchanges between different actors in the chain: the formal and informal contracts. The formal institutions are the second level. This is the level of the rules of the game, such as defining and protecting property rights, the political decision-making structure, and the judiciary system. Value chains will only prosper if the economic conditions, the governance and institutional conditions are right. Formal institutions are more important than informal ones. As Dixit has argued, the relative importance of formal institutions increases as the scope of market exchange broadens and deepens (Dixit, 2004). One reason is that setting up formal institutions requires high fixed costs but low marginal costs, whereas informal institutions have high marginal costs. Formal institutions reduce uncertainty on e.g. finding buyers, contract enforcement, or price discovery. As the Ethiopian government aims at broadening the export portfolio, having formal institutions that comply with internationally acceptable standards is of high importance.

Several approaches are used in this report, depending on the research question and the level of institutions. The approaches used are literature reviews, analyses of available data, a business economic evaluation of opportunities for oil processors and farmers, an institutional economics framework for governance issues and a strategic management approach for deriving the business opportunities for the value chain. Optimisation techniques are used on farm level and for determining the value of the by-products - oil cakes - in animal feed. Evaluation of business opportunities is based on comparing the opportunity with alternatives. Soya bean cake as cattle feed, for instance, is a substitute for a mix of cereals, leguminous crops and oilseeds.

The report focuses on growing oilseeds crops and the processing of these seeds into edible oil. The value of oil cake is taken into account. The demand for such products for husbandry or for the substitution of animal products by vegetable products is not analysed.

Table 1.1 Four levels of social analysis

	Level	Frequency	Purpose	Theory
1	Embeddedness: informal institution, customs, traditions, norms, religion	100-1,000 years	Often non-calculative; spontaneous	Social theory
2	Institutional environment: formal rules of the game esp. property (polity, judiciary, bureaucracy)	10-100 years	Getting the institutional environment right	Economics of property rights, positive political economy
3	Governance: play of the game - esp. contract (aligning governance structure with transactions)	1-10 years	Getting the governance structure right	Transaction costs economics
4	Resource allocation and employment (prices and quantities; incentive alignment)	Continuous	Getting the marginal condition right	Neoclassical economics/ agency theory

Source: Williamson (2000).

1.2 Structure of the report

Chapter 2 provides background information on products made from soya beans and sunflowers seeds, either raw or processed, and their substitutes. The next four chapters follow the products upstream in the value chain from consumption to production at farm level. Chapter 3 discusses the development of the consumption of fats and proteins, its relation to income and prices of edible oil. In this chapter, we also discuss the Ethiopian production and trade in oilseeds and edible oil and food balances. Finally, we present data on the share of the own yield that is consumed on the farm. Chapter 4 analyses edible oil processing, the performance of the manufacturers, the reasons for the low capacity utilisation, food safety issues, and the value of the by-products in the animal feed. Intermediaries and traders are the subject of Chapter 5. The production at farm level is analysed in Chapter 6. We discuss the agronomic and economic possibilities. For that reason, a farm optimisation model has been developed to analyse the attractiveness of these new crops. This model analyses the impact of different prices or yields. E.g., we analysed the impact of best-practice yields compared to actual yields and the impact of credit facilities.

These analyses and descriptions are the input for the business opportunities and key success factors for the new crops soya beans and sunflower in Chapter 7. We will analyse the opportunities from an economic, governance or institutional and strategic management viewpoint. In Chapter 8 we reflect on several assumptions and results in a wider perspective. Finally, in Chapter 9, we present some recommendations.

2 Soya bean and sunflower products and their substitutes

Key findings

- Soya beans contain 20% oil and are rich in proteins. The proteins are suitable as meat substitutes and for several food and feed applications.
- Soya beans and soya oil cake for animal and human consumption have to be processed, to increase digestibility and to reduce its off-flavour.
- For soya beans, usually solvent extracting is used. Expellers will extract less than 50% of oil from the seeds.
- Soya beans and sunflower products are not necessary to fulfil the recommended Dietary Reference Intake; actually grown crops can also fulfil this intake.
- Most edible oils can be consumed either as crude or as refined oil.
- Soya bean and sunflower oils have a higher level of the preferred mono- and polyunsaturated fatty acids than palm oil that is imported in large quantities.

2.1 Soya bean products

Soya beans have been grown - although to a very limited extent - in Ethiopia at least since the fifties, especially as a protein source. In a pilot in the seventies, farmers were taught how to cultivate the crop and how to use soya beans as an ingredient in their local dishes and food habits (Seegeler, 1983). The protein contents range from 14 to 23% and the oil content from 32 to 50%. Proteins and lipids make up around 60% of the soya beans. The contents of both depend on cultivar, agronomic and climatic conditions. Trade-offs exists between yield and protein content and between protein and oil content. Strains with higher protein have lower oil content (Salunkhe et al., 1992).

Off-flavour and off-aroma are limiting factors in using soya bean products. Degradation of polyunsaturated fatty acids (linoleic and linolenic) and the enzyme lipoxygenase are responsible for the off-flavour. The flavour depends on handling and processing. Soya beans have few direct uses for consumption and differ in this respect from many other oilseeds. The seeds have to be processed for human consumption and the major use is meal for animal feed (Weiss, 2000).

Box 2.1	FAFFA Food Share Company, Addis Ababa

The company is an Ethiopian-Swedish joint venture with the objective of reducing malnutrition among children in Ethiopia by providing low-cost, high-protein weaning food. They use soya beans to produce high-protein food and other food supplements. Currently their largest customers are the aid industry, for instance. the World Food Programme, UNCHR, UNICEF, Christian Relief, and development associations such as Euro Aid, Ogaden Welfare Association and other NGOs. The company has 2 broad product categories, i.e. commercial (wheat flour, cornflakes, milk) and relief products (Famix and Cerifam). The latter are corn-soya blends. The ratio of relief to commercial soya bean products was 74% to 26%. However, that ratio has been cut to 25% to 75%. The forecast of their demand in 2010 is 2,109 tonnes of soya beans.

Soya beans are currently the world's most important source of vegetable oil. Soya beans are usually dried to reduce the moisture content to less than 12% and can be stored for 2 years without change in grade. Long-term storage will reduce the nutritive value more than that of e.g. wheat. High moisture contents encourage growth of fungus and mould and can result in higher acid values of the oil. Beans with a 14% or higher moisture content are usually dried before storage (Wolf et al., 1971). Soya beans are processed into oil and flakes. Soya oil is usually extracted from soya beans after dehulling and flaking using solvent (hexane) extraction. Oil expelling using oil presses is possible, but the meal will usually have high residual fat content (>10% of the total oil cake weight, so over 50% of the oil in the seed).

The defatted flakes can be used as meal in animal feed or as protein in food. The defatted soya flours after extraction oil is rich in proteins (above 50% proteins) and contains about 1% fat. This flour can be processed in concentrates (more than 60% proteins) or in isolates (more than 80% proteins) by extracting sugars, ash, and other constituents. From these products, textured protein products can be made, with chewy and fibrous properties. Table 2.1 shows the food products based on these 3 products. The oil, as many other edible oils, is used as cooking oil, salad oil or dressing, in shortenings (bakery cooking fat) and in margarine.

In the past soya oil has been used as industrial oil due to the high linolenic acid content and the unpleasant odour when used for frying. Industrial use, non-food or feed use is below 10%. Substitutes are cheaper and used instead of soya oil. Soya oil is semi-drying and is used for paint, varnish, plastics and similar products (Weiss, 2000).

Fresh whole soya beans are not easily digested because they contain anti-nutritional factors and off- flavour compounds. Before being edible they must be soaked and cooked for a long time or processed such as roasted, fermented or sprouted (Giller and Dashiell, 2007). Full-fat soya beans that are heat treated can be used as animal feed. Whole soya bean products are mainly used in the East as soya milk, tofu, miso, and tempeh. Furthermore, sprouts from soya beans are well known in Asian food.

Table 2.1 Food products from soya proteins

Protein form	Minimum protein (%)	Used in food products
Flours	50	Baked products Non-fat dry milk replacers Breakfast cereals Diet foods Infant foods Soup mixes Confections
Concentrates	60	Processed or frozen meat Breakfast cereals Infant foods
Isolates	90	Processed meat Dry milk replacers/coffee whiteners Infant foods Casserole mixes Cake mixes Beverage mixes and products Confections
Textured flours	50	Ground beef (extenders) Processed meats Meat analogues Baked snacks
Textures concentrates	60	Ground beef soy blend Processed meats Seafood extenders Meat analogues
Textures isolates	90	Meat extenders Meat analogues

Source: Salunkhe et al. (1992, p. 36).

2.2 Sunflower seed products

Sunflower - 'white man's safflower'- has been known in Ethiopia since the beginning of the 19th century (Seegeler, 1983). The crop received little interest despite research stations obtaining good yields. According to Salunkhe et al. (1992), the chemical composition of sunflowers is comparable to that of peanuts, which are a widely grown in Ethiopia: the same amount of fats and essential amino acids, but richer in polyunsaturated lipids.

There are two types of sunflower seeds: for oil processing or for confectionery. The latter seeds are consumed as whole seed and represent less than 10% of the total sunflower production. Salunkhe et al. (1992) report oil contents between 32 and 54%, depending on the cultivar and author. Sunflower oil contains more unsaturated fatty acids than most other oilseeds and is seen as a premium edible oil (Salunkhe et al., 1992). The oil content of the Ethiopian varieties ranges between 25 and 33% (Seegeler, 1983). This low level of oil content suggests that in Ethiopia sunflower seeds were used for direct consumption.

Oil extraction of sunflower is possible by oil pressing or a combination of oil pressing and hexane extraction of the residual oil from the seed meal. As crude sunflower oil contains low levels of free fatty acids (FFA), it does not need not to be refined extensively. Commercially available defatted meal from oil extraction of whole seeds is not suited for human consumption because of the high fibre levels. For human consumption of the seed meal, the seeds have to be dehulled before oil extraction and processed to remove polyphenolics (Gandhi et al., 2008).

2.3 Ethiopian substitutes for soya bean sunflower seed products

Soya bean and sunflower products compete with other crops: for oil with other oilseeds and for protein with leguminous crops. Proteins, fats, essential amino acids, and essential fatty acids composition determine the nutritive value of the new crops. The nutritive value of soya beans and sunflowers is compared with the most important Ethiopian leguminous and oil seed crops in Figure 2.1. Humans require some fatty acids that the body itself cannot make from other components, but must ingest. These essential fatty acids (EFA) are alpha-linolenic acid, an omega-3 fatty acid, and linoleic acid, an omega-6 fatty acid (Wikipedia, 2010). Also, humans cannot produce the ten amino acids that are essential for maintaining the body's protein level (e.g. muscles). In contrast to fat and starch the body cannot store these acids and has to be in the food every day. Humans do not have all the enzymes required for the biosynthesis of all the amino acids (Arizona, 2010). Appendix 1 presents detailed nutritive properties of the selected seeds taken from the USDA National Nutrient Database (USDA, 2010).

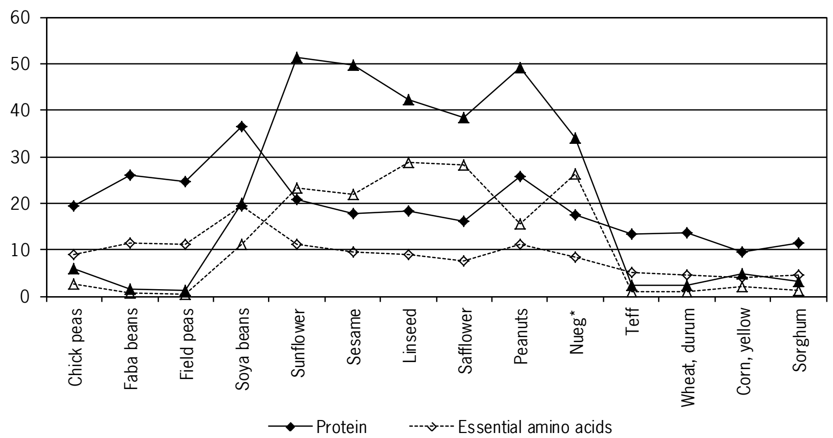
Soya beans have a relatively high level of protein compared to other leguminous crops and oilseeds grown in Ethiopia. Consequently, soya beans have a competitive advantage, but the oil content is low compared to other oil crops. Sunflower seed composition is more or less comparable to that of other oilseed crops grown in Ethiopia

Table 2.2 **Sunflower seed products**

Product	**Processing**	**Use**
whole seeds		**bird seed**
Large-sized (>8 mm) seeds in shell	Roasting	Snack: sunflowers for cracking
Medium-sized seeds	Dehulling and roasting	Peanut substitutes Confectionary Snack (after salting)
Sunflower butter	Grinding dehulled and roasted seeds	Similar to peanut butter, but less taste
Edible oil	Extracting and refining	Cooking oil Salad oil Margarine
Protein products human food	By-product after extraction of dehulled seed	Protein products. These are comparable or better than from soya beans (see Table 2.1)
Defatted meal in animal feed	By-product of extraction	Feeding cattle due to high fibre and low protein levels
Hull	By product after hulling	Animal feed (roughage), bio-fuel
Industrial products		Lacquers, polyester, plastic. As semi-drying oil less suited for paints

Source: Salunkhe et al. (1992).

Figure 2.1 **Properties in grams per 100 grams of seeds**



Based on: USDA (2010).

Another benchmark might be the Dietary Reference Intake (DRI) of different nutrients (Table 2.3 shows the main nutrients). Appendices 1 and 2 provide detailed information on nutrient contents for all crops and DRI values. The protein and essential amino acid DRI can be met by any single crop, provided the intake of that crop is sufficient to meet the DRI for energy. At this level of energy intake, however, the DRI for fats will not be met using any of the non-oil crops. Only with oilseeds in the diet, the DRI for fats can be met. Diets meeting the DRI of all nutrients are possible using only the traditional set of Ethiopian crops - so without soya and sunflower.

Table 2.3 **Recommended Dietary Reference Intake**

	Adult male	Adult female
Energy (Kcal)	2400.0	2000.0
Protein g	56.0	46.0
Fat (g)	50.0	38.0
Poly unsaturated fat (g)	18.6	13.1

Source: Food and Nutrition Board (2002).

2.4 Crude or refined oil?

Oxidation is the major cause of deterioration of edible oil. Due to oxidation the concentration of unacceptable odours and off-flavours increases. Furthermore, oxidation destroys essential fatty acids, produces toxic compounds, and thus decreases the shelf life. Refining removes compounds responsible for oxidation but in contrast, crude oil contains compounds that contribute to the stability of the oil (Koski, 2002). Moreover, a German study shows that crude oils as well as refined oils are commercially available in Germany (see Table 2.4).

These issues raise the question: 'Can edible oil be consumed without refining?' Olive oil is a well-known example of oil that can be consumed without refining; this is called virgin olive oil. This high quality oil has an appealing taste and a higher nutritional value than refined oil. However, crude oil contains compounds that catalyse oxidation like free fatty acids, mono- and diacylglycerols and metals. In contrast, anti-oxidants and pigments (chlorophylls) contribute to oxidative stability of cold-pressed (Choe and Min, 2006; Koski, 2002).

Lute (2011) provides an overview of the properties of crude and refined oil. That overview in Table 2.4 mainly answers the question: 'In which form can the oil be consumed?' Notable and in contrast to the German source, Salunkhe (1992) says that oils from soya, palm, sunflower, and cotton need refining before they are used for edible purposes.

2.5 Sunflower and soya bean oil and Ethiopian substitutes

Linseed and neug oil, produced in Ethiopia, are comparable with sunflower oil in the total percentage poly-unsaturated fatty acids (see Table 2.4). In addition, the content of poly-unsaturated fatty acids is higher than in soya bean oil. However, sunflower and soya bean oils have a better composition of fatty acids than palm oil. Imported palm oil is an important cooking oil in Ethiopia. Even rapeseed oil, important on the domestic market, has a better fatty acid composition. Furthermore, palm oil is rich in saturated fatty acids. Sunflower and soya oils, then, have excellent substitutes in Ethiopia. However, the fatty acids composition is considerably better than that of imported palm oil.

Table 2.4	Properties of crude and refined oil a)	
Oilseed	**Properties**	
	crude oil	**refined oil**
Neug	- Locally extracted and consumed - Poor shelf-life, soon becomes rancid - Slight nutty taste and sweet odour	- Heating of oil prolongs the shelf-life - Refining is possible
Linseed a)	- Raw and cold-pressed oil is used - Most of the oil is used for non-edible purposes - Mild and nutty taste; however, after one day of storage bitter off-taste due to oxidation	- Refining avoids the bitter off-taste (co-refining with other plant oils required) - Nutty taste is removed as well
Sesame a)	- Appreciated oil with an excellent quality - Nutty flavour, amber to yellow colour - Stable oil, high concentration of antioxidants, tocopherol	- In EU and Asia mainly refined oil is used - Taste and colour are lost by refinery
Soya bean a)	- Needs further processing, due to off-flavours - Beany flavour	- Almost all soya bean oil is refined - Widely used in the food industry
Sunflower a)	- Practically free of toxic components - Light amber in colour	- Does not need refining, but is mostly refined - Pale yellow
Cotton seed	- May contain aflatoxins - Strong characteristic flavour and odour	- Excellent edible oil after refining - Inactivation aflatoxins
Rapeseed a)	- Used for cooking in developing countries - Relatively high amount of phosphatides - Dark yellow or amber	- Needs to be refined in developed countries - Light yellow colour
Peanut a)	- Used for cooking in developing countries - Slightly sweet, green, and nutty flavour - Slow deterioration - May contain aflatoxins, this can be inactivated	- Needs to be refined in developed countries before consumption - Detoxification aflatoxins
Palm a)	- Use of crude oil is decreased - Non-glyceride impurities - Dark yellow or red colour (carotenoid) - Stable towards oxidation (high tocopherol content)	- For food purpose refining needed

a) In crude form, these oils are commercially available in Germany.
Source: Lute (2011).

Table 2.5	**Nutrient values per 100 grams of edible oil**						
Nutrient	**Unit**	**Palm**	**Linseed**	**Soya bean**	**Sun-flower**	**Rape-seed**	**Neug**
Water	g	0.0	0.0	0.0	0.0	0.0	0.0
Energy	kcal	884.0	884.0	884.0	884.0	884.0	884.0
Protein	g	0.0	0.0	0.0	0.0	0.0	0.0
Total lipid (fat)	g	100.0	100.0	100.0	100.0	100.0	100.0
Lipids, total fatty acids							
Saturated	g	49.3	9.4	15.3	10.3	6.4	n.a.
Monounsaturated	g	36.0	20.2	22.6	19.5	63.3	n.a.
Polyunsaturated	g	9.3	66.0	56.3	65.6	28.1	>60.0
18:2 undifferentiated	g	9.1	12.6	50.3	65.6	19.0	>60.0
18:3 undifferentiated	g	0.2	53.3	6.0	0.0	9.1	

Based on: Bulcha (2007), USDA (2010).

3 Edible oil and proteins consumption and supply

Key findings

- The average protein consumption per capita in Ethiopia meets the Dietary Reference Intake, but the energy and fat intake is below the DRI.
- The income in GDP per capita rose by 6% annually and doubled in 15 years.
- The consumption of fats and proteins increased by 2%, an increase of 30% in 15 years.
- Unspecified edible oil, presumably from linseed and neug, accounts for 40% of the total fat consumption of 1.6kg per head, palm oil accounts for 22%, and soya bean oil for 16%.
- The increase in the export of oilseed was 25% annually; the increase in the imports of edible oil was 12% annually.
- The production of oilseed increased 9% annually, higher than the 6% annual increase in consumption of edible oil.
- A major and increasing part of the export earnings of oilseeds (i.e. sesame and neug) are used to import edible oil. The trade balance is positive in fat supply for Ethiopia
- Locally produced cooking oil has a consumer price premium ranging from ETB1.50 in rural areas to ETB4.30 in Addis Abba.
- Prices of imported oil do not differ between regions, but locally produced oil is up to ETB2.40 more expensive in Addis Ababa compared to rural areas.
- The major part of the crops (over 60%) is consumed or used as sowing seed (15-20%) on the own farm.

3.1 Trends in consumption of fats and proteins worldwide

The 1948 Universal Declaration of Human Rights includes the right to adequate food and is formulated as follows (UNCHR, 2010):

> 'The right to adequate food is realised when every man, woman and child, alone or in community with others, has physical and economic access at all times to adequate food or means for its procurement.'

The right to food has three elements: availability, accessibility or affordability and adequacy (e.g. satisfying the dietary needs). We analysed the adequacy (meeting the dietary needs) of energy, proteins and fat by comparing per capita consumption with the Dietary Reference Intake (Table 3.1). The DRI is taken from adult persons and is therefore rather high: youngsters and elderly need less (Food and Nutrition Board, 2002). Given that 46% of the Ethiopian population is younger than 14, calculating the food demand based on a DRI determined for adult persons may overestimate the total requirement for Ethiopia to some extent. Worldwide the consumption exceeds the DRI for all 3 categories. Ethiopians only meet the protein DRI and thus have a low energy (kcal) intake. The fat intake is almost half the DRI and should be considered as inadequate.

Table 3.1 Consumption in 2006 and Dietary Reference Intake of energy, proteins, and fats

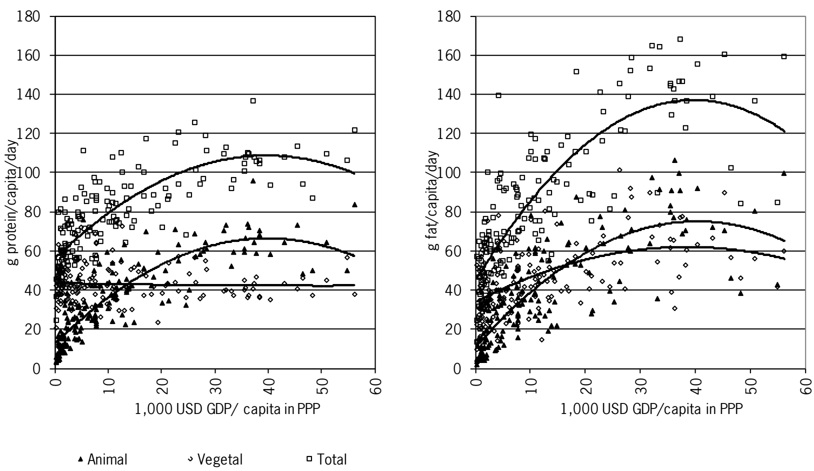
	kcal/capita/day			protein g/capita/day			fat g/capita/day		
	animal	vegetable	total	animal	vegetable	total	animal	vegetable	total
World	481	2,315	2,696	29.8	46.3	66.1	35.3	44.2	69.5
Ethiopia	96	1,884	1,980	6.0	50.6	56.6	6.8	14.1	21.0
Netherlands	1,058	2,220	3,268	68.3	36.5	104.6	66.0	60.6	136.6
DRI Male 31-50 years			2,400			56.0			50.0
DRI Female 31-50 years			2000			46.0			38.0

Source: FAOstat and Food and Nutrition Board (2002).

The Ethiopian food consumption will rise with rising income. Figure 3.1 shows that the protein intake rises with the income, until USD40,000 PPP GDP per capita, after which level it slightly decreases. The growth of animal proteins - mainly meat - contributes almost fully to that higher protein consumption. The consumption of vegetable proteins remains on a constant level. With a GDP of USD800 PPP per capita, Ethiopia is on the left side of the figure:
the Netherlands - with a GDP of USD40,000 PPP - is on the right side of each graph. With a rising income, the animal fat consumption - mainly meat - increases faster than the vegetable fat consumption. For low incomes, up to USD5,000 GDP per capita, vegetable fats dominate fat consumption. With a GDP per capita of less than USD1,000, Ethiopia is expected to first increase the consumption of vegetable fats. Consumption of animal products is linked to culture,

which in this case means that the Ethiopian consumption of animal products will be mitigated by religion, since there are many fasting days on which meat is not consumed.

Figure 3.1 **Protein and fat intake related to income (GDP in USD PPP/capita) in 2007**



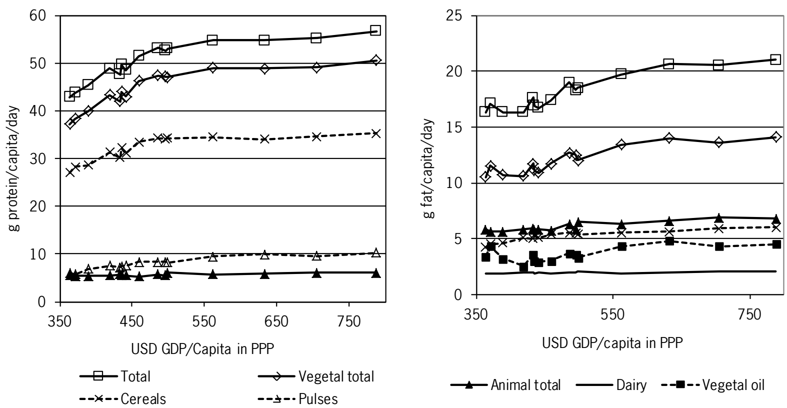
Based on: FAOstat and World Development Indicators.

3.2 Ethiopian fat and protein sources

From 1993 to 2006, total fat and protein supply and consumption increased from 43 to 56 g of protein and 16 to 22 g of fat per person per day, an increase of 30% (or 2% annually). This increase coincided with an annual increase of GDP per capita of approximately 6%. A further doubling of the income in the next 12 years may be expected and a consequent increase in the consumption of protein and fats per capita may therefore be expected by 30%. Remarkably, the increase in fat and protein consumption primarily came from increased consumption of plant products, while the meat and dairy consumption did not increase much (Figure 3.2).

On average, 90% of protein consumption comes from plant products: 64% from cereals, 16% from pulses (leguminous), 10% from oil seed crops, and only 11% from animal products. Two-thirds of the fat consumption comes from vegetable sources. Cereals and edible oil each account for about one third of the plant-based fat intake, and animal fat for the remaining one third. The shares of the different sources did not change much from 1993-2006 (Figure 3.2). Despite the strong growth of the Ethiopian income, it doubled, the level remains low (see Figure 3.1). This might be the cause of the limited changes in the different sources.

Figure 3.2	**Protein and fat supply related to income in Ethiopia from 1993 to 2006**



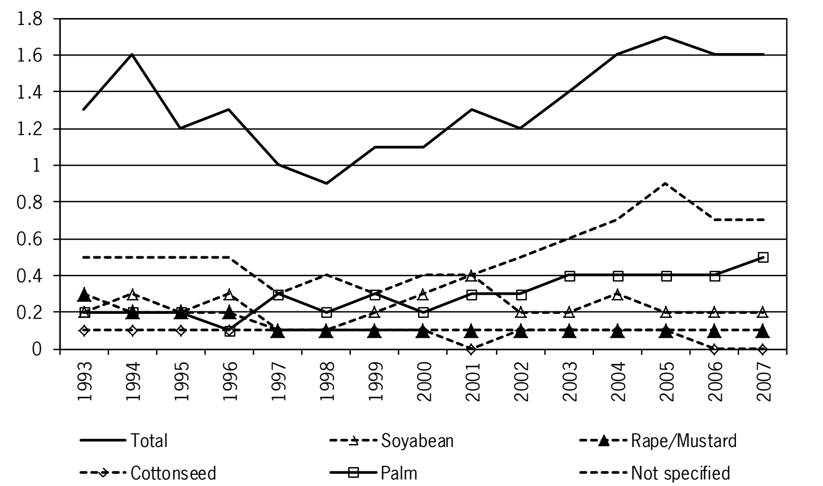
Source: FAOstat and WDI.

3.3 Consumption of specific edible seed oils

The consumption per capita of edible oil in Ethiopia has grown from 0.9kg in 1998 to 1.6kg in 2005 per year: far below the world average of 11kg. Domestic production of 'not specified' edible oil accounts for the major part: approximately 40% (see Figure 3.3). Although not specified by FAO, given the large production of linseed and neug, 'not specified' edible oil must mainly consist of these oils. Since 2003, edible oil imports are increasing fast. Nowadays, palm oil, with an average share of 22%, and soya bean oil, with an average share of 16%, are the second and third source. Rape/mustard oil and cotton oil are less important with average shares of 10% and 6%, respectively. In total, these five oil categories supply 95% of the edible oil.

The consumption of unprocessed oilseeds has grown from 0.2 in 1993 to 0.6kg per capita per year in 2006. The edible oil represents approximately 3.5kg of unprocessed seeds. In total, the consumption of oilseeds is around 4kg per capita per year, or 12 g per capita per day.

Figure 3.3 **Supply of edible oil in kg per capita**

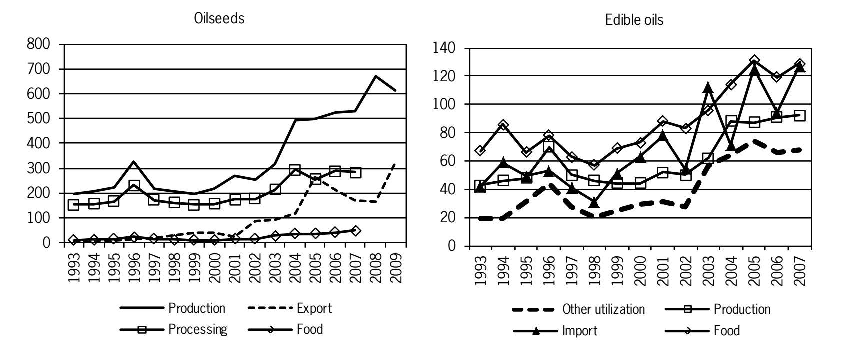


Source: FAOstat.

3.4 Ethiopian food balance in fats and proteins

On the one hand, Ethiopia exports oilseeds to earn foreign currency and on the other hand, it imports edible oil to supply the population with cooking oil. The production of oilseeds and vegetable oil has been growing since 2000. A major part of the larger production of oilseeds is exported, while at the same time the imports of edible oils also increased. Figure 3.4 presents the developments and Appendix 3 provides the detailed data. The amount of processed oilseeds increased at a slower pace than the exports. The export of oilseeds reached an all-time high in 2009. Sesame is the main export crop. Although the direct consumption of oilseeds increased, it remained on a low level. The supply of domestically produced oil increased due to the higher levels of the processed quantities. Not only the human consumption increased but also the quantity for other uses of edible oils. During the period from 1993 to 2006, the domestic production of edible oils did not meet the human consumption level and during the last years that gap widened. Of the total domestic oil supply 65% is imported, consisting mainly of palm, soya bean and sunflower oil. The oil imports account for on average 90% of the consumption between 2003 and 2007.

Figure 3.4 Food balances of oilseeds and edible oils in 1,000 tonnes

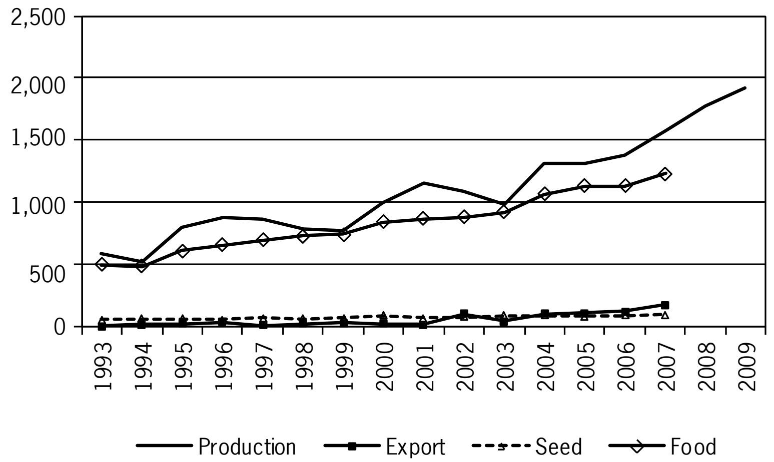


Source: FAOSTAT, UNcomtrade export data for 2008 and 2009.

The production of oilseed grew annually by 9%, the export of oil seeds by 25%, the domestically produced edible oil by 6% and the consumption of edible oil by 6%, resulting in an import growth of edible oil of 12%.

The production and consumption of pulses, a major source for proteins, doubled in the past 15 years, which is an annual increase of 6%. Furthermore, the export of pulses also grew and surpassed the amount needed for seeds (Figure 3.5). The majority of the produced pulses are used for human consumption. The consumption grew at the same pace as production. Appendix 3 provides detailed information and shows that the 'other utilisation' of pulses increased, most likely for animal feed.

Figure 3.5 **Food balances of pulses in 1,000 tonnes**



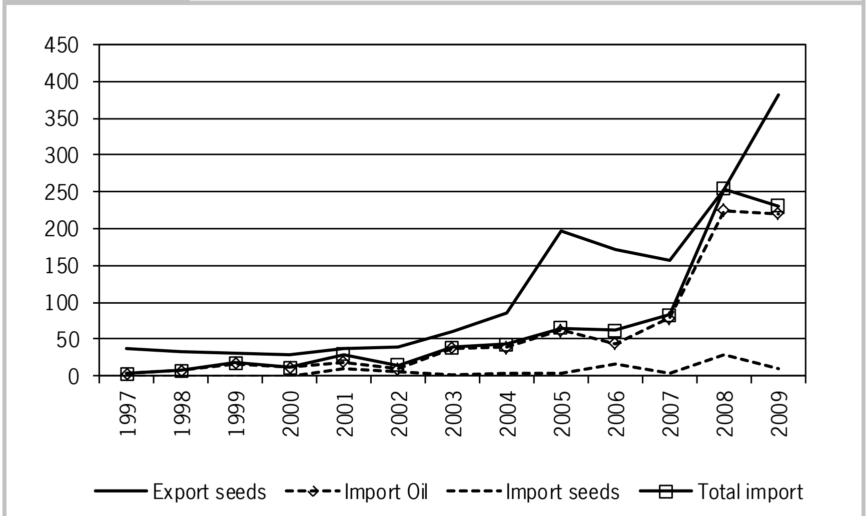
Source: FAOSTAT.

A major part of the export earnings from oilseed is needed to import edible oil. In 2008, a year with high agricultural commodity prices, the earnings and expenditures were at the same level (Figure 3.6). During the period from 2003 to 2007, the export earnings grew faster than the import expenditures of oil or oilseeds. In recent years, the value of imported edible oil seems to grow faster than the export value, narrowing the gap between export earnings of oilseeds and import costs of edible oil. Domestic demand is expected to grow the coming years due to population and income growth. The challenges for Ethiopia are:

1. A higher domestic production of edible oil instead of exporting oil seeds, thereby generating more value added and employment;
2. A higher production of seeds, enabling exports to remain on the same level or even grow, and a higher domestic edible oil production.

Ethiopia exports on average 190,000 tonnes of sesame seed and 35,000 tonnes of other seeds - mainly neug - with a value of USD232m during the period 2005-2009. The total oil content of these seeds is around 115,000 tonnes, or 93,000 tonnes of edible oil if the extraction effectiveness is 10% fat in the oil cake. This amount of edible oil is below the import of 117,000 tonnes of oil. The value of the imported oil, USD126m, is far below the export value of the oilseeds. This trade, then, results in a positive food supply balance.

Figure 3.6 **Ethiopian import and export in USD million**

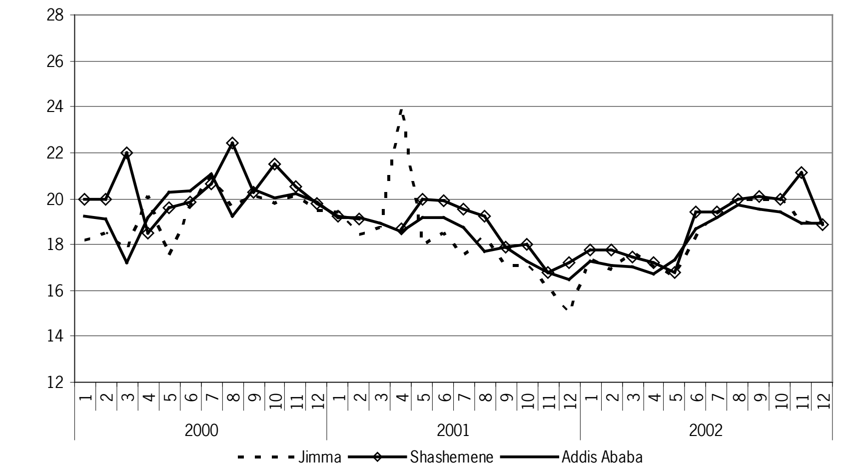


Source: UNcomtrade.

3.5 Consumer prices of edible oil

Consumer prices of local cooking oil are higher than of imported cooking oil. On the Jimma market, local oil is ETB1.88, on the Shashemene market ETB1.38 and on the Addis Ababa markets ETB4.30 higher than imported oil in the period from 2006 to 2010. Figure 3.6 shows the price premium for locally produced oil. As most of the imported oil consists of palm and soya bean oil, this means that Ethiopian consumers prefer the local oil, mainly based on linseed and neug. Representatives of the Adama oil mill said that Ethiopian consumers prefer neug oil.

Figure 3.7	Price premium of locally produced cooking oil in ETB



Source: www.csa.gov.et

Table 3.2 shows that the price of imported cooking oil is almost on the same level in the selected regions. The price of local oil is the highest in Addis Ababa: the price difference with the other regions is on average ETB2.00 but can be up to ETB6.00. These price differences give an indication of the logistic margin. Appendix 4 provides the prices at a monthly basis.

Table 3.2 **Prices of cooking oil in ETB per litre on three markets**

	Jimma		Shashemene		Addis Ababa	
	import	local	import	local	import	local
2006/2008	19.32	19.94	20.43	22.65	19.68	24.06
2008/2009	18.19	20.63	18.69	19.35	18.26	22.11
2009/2010	18.43	21.26	18.83	20.29	18.32	22.96
overall	18.64	20.64	19.33	20.61	18.65	23.05

Source: www.csa.gov.et

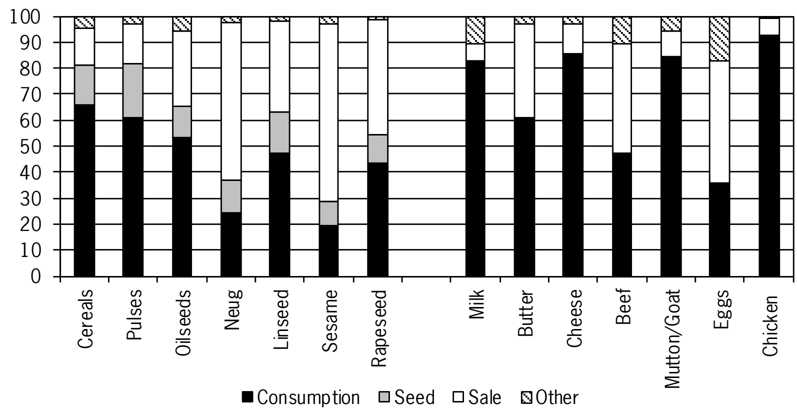
3.6 On-farm consumption

Ethiopian farmer's households use most of their agriculture production for their own consumption. Figure 3.8 and Appendix 5 show the share of production used for consumption on the own farm. Over 80% of the produced cereals and pulses and 65% of oilseed production are used for either own consumption or sowing seeds. Cereals are the most important food crop, the production of which amounts to 145m tonnes per year, followed by 20m tonnes of pulses. The production of oilseeds, 6m tonnes, is a mere 5% of the cereal production. Neug, sesame seed, rapeseed, beef and eggs are mainly sold, providing the farmer's cash.

This use of own produce means that the level of industrial food processing is very low. Furthermore, own food is cheaper than buying food on the market: the margins of wholesalers and retailers are not charged. If farmers grow soya beans, these will be mainly used as cash crop. Because of its off-flavours, soya beans are unsuitable for own consumption. Growing soya beans or sunflowers will compete with other cash crops.

This home consumption shows a strong relation with the part of the population (83%) living in rural areas and the employment level in agriculture (80%).

Figure 3.8 **Percentage utilised of production 2008/2009 (2001 E.C.)**



Source: CSA (2009b).

4 Edible oil processing

Key findings

- The production value of small-scale oil and fats manufacturers is equal to the large and medium-sized processors.
- In urban regions, especially Addis Ababa, most formal food manufacturers are located.
- The average processing margin is 33% of the raw material costs, for small-scale operators this figure is 13% and for the large and medium-scaled 64%.
- The informal sector, not registered in the CSA manufacturers' statistics, produces 86 to 88% of all domestically produced edible oil.
- Over 50% of the small-scale manufactures mention lack of raw materials and absence of market demand as the main reason for not working at full capacity.
- Oil manufacturers face problems with equipment/capital, smooth supply of raw materials, obstacles from governmental rules and regulations, and skills of employees.
- The Ethiopian standards dealing with hygiene, traceability, recall, and labelling meet the EU requirements, however Ethiopia does not meet the stricter EU requirements on additives, contaminants, pesticides, GMOs, and erucic acid.

4.1 Economic importance edible oil manufacturing industry

Food is important in the total manufacturing industry: it provides 40% of the employment and gross value of production of total manufacturing (Table 4.1). The economic importance of vegetable and animal oil and fats manufacturers is low: their share in total manufacturing is below 1% for persons engaged, gross value of production or value added.

Ethiopian small-scale enterprises (1 to 9 persons) in the total manufacturing industry are rather important in employment (share 53%) but low in gross value of production (share 10%) and value added (share12%). In contrast, the small-scale oil and fats manufactures have larger share: 52% of the total gross production value and 12% of value added per person. Food manufacturing provides little employment (less than 140,000 persons) compared to the primary production (millions of persons are engaged).

Table 4.1	Total, food, and oil and fats manufacturing industry in 2006/2008						
Scale		**Number**	**Persons engaged**	**Pers./ firm**	**GVP a)**	**GVP/ person**	**VA a)**
					ETB million	**ETB 1,000**	**ETB million**
Small	Manufacturing	43,338	138,951	3.2	2,691	20	1,248
	Food	*24,588*	*64,661*	*3.0*	*1,422*	*19*	*565*
	Oils and fats	*259*	*1,129*	*4.4*	*135*	*120*	*11*
	Grain millers	*23,046*	*60,023*	*3.0*	*1,114*	*16*	*511*
Large and medium	Manufacturing	1,900	133,663	60.4	22,986	162	9,166
	Food	*465*	*41,681*	*86.6*	*8,651*	*210*	*3,866*
	Oils and fats	*33*	*1,469*	*44.5*	*135*	*92*	*41*
	Grain millers	*122*	*6,546*	*53.6*	*1,146*	*165*	*162*
All	Manufacturing	45,238	262,624	6.0	25,668	95	10,415
	Food	*25,063*	*116,452*	*4.6*	*10,164*	*86*	*4,452*
	Oils and fats	*292*	*2,598*	*8.9*	*260*	*104*	*52*
	Grain millers	*23,169*	*66,569*	*3.3*	*2,261*	*30*	*663*

a) GVP Gross Value of Production at market prices, VA Value added at market prices.
Source: CSA (2009d); CSA (2010).

The majority of the large and medium sized food manufactures - 235 out of 485 - are located in Addis Ababa (CSA, 2009c). Of the small-scale grain millers 1,586 (56% of the total) are located in an urban region with 260 (10%) small grain millers in Addis Ababa. In the rural areas 1,236 (44%) grain millers are located (CSA, 2010). Most grain millers are small scaled, just like oil and fats manufacturers. These high numbers in urban areas are remarkable because over 80% of the population is living in rural areas.

4.2 Processing of oilseeds into edible oil

The production of edible oil consists of different steps and depends on the desired application. Figure 4.1 shows the process steps from oilseeds to the final product. First, crude oil is obtained from oilseeds by pressing. Crude oil can be marketed directly, like virgin olive oil. However, often crude oil demands refining to be suitable for human consumption. Refining aims to remove undesirable properties from the oil (see Section 2.4). We will discuss the oil processing steps in more detail.

Production of crude oil

The production of crude oil consists of seed preparation and extraction. Seed preparation aims to remove impurities whereas extraction gives the first pressed oil and is the most important step for the yield of the oil (Weiss, 2000).

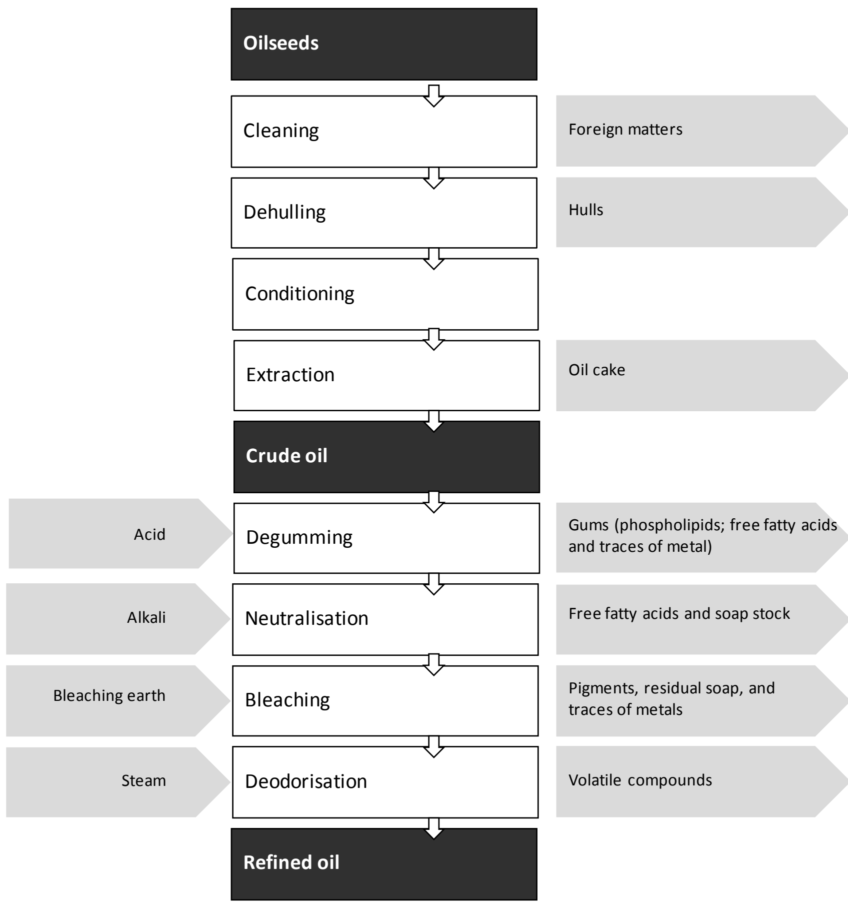
Seed preparation consists of seed cleaning, dehulling, and conditioning. First, impurities as straw, dead seeds, and soil will be removed from the oilseeds by using seed cleaners, sieves, and magnets. Removal increases the quality of the oil and reduces the risk on damaging of the equipment (Ferchau, 2000). For a more effective extraction, dehulling will be applied by flaking the seeds (Hamm, 2003a). Through conditioning, the efficiency of the oil extraction increases. By using heat and moisture, oil seeds are being prepared for oil extraction. Next to the improved efficiency, some enzymes will be deactivated and undesirable impurities became insoluble(Hamm, 2003a).

Extraction removes oil from seeds and can be done in two ways: mechanically or with solvents. In the mechanical way, a screw process extracts oil from oilseeds either with or without the application of heat. In cold-pressed oil, some impurities remain but flavours and colours retain in the oil (Strayer, 2006). However, cold pressed-oil has a lower yield and is more susceptible than extraction with the application of heat (Koski et al., 2002). For oil, pressing a wide range of equipment is available from hand presses (e.g. Yenga oil seed press) to small-scale motorised oil presses and very large-scale extruders or screw presses. In many cases, solvent extraction follows up the screwing process. Solvent extraction aims to get increased oil recovery by separation the liquid from the solid phase. Furthermore, the residual product is called *cake* and is used for animal feed (Hamm, 2003a; Weiss, 2000).

Production of refined oil

Undesirable properties and fatty impurities as phospholipids and free fatty acids influence the stability of the oil(Hamm, 2003b, Martinho et al., 2008). Free fatty acids are not attached to other molecules where they are normally attached to glycerol in a triglyceride In addition, phospholipids are almost similar to triglycerides but contain a water-soluble (phosphate) group instead of a fatty acid (Vaclavik and Christian, 2003).

Figure 4.1 **Production of edible oil**



Source: Lute (2011).

Refining aims to produce a stable oil without impurities and it has the largest effect on the quality and yield of the oil (Hamm, 2003a; Eyob Tadewos, 1992). Refining consist of degumming, neutralisation, bleaching, and deodorisation. Degumming by adding acids aims to remove phospholipids, free fatty acids, and traces of metal. Degumming results in reduced emulsifier properties, minimised refining loss and it makes processing at high temperatures possible(Hamm, 2003a). Moreover, neutralisation aims to eliminate the number of free fatty acids and residual compounds named as soap stock. The process will be done at 80-90°C with alkali, generally a sodium hydroxide solution. During a mixture procedure, the free fatty acids should be decrease to 0.1% and end up in residual soap. If neutralising is performed poorly, further steps will not operate properly. Furthermore, bleaching takes out impurities as natural pigments, residual soap, and traces of metals. This stage uses acid-activated bleaching earth under pressure (50 mbar). Bleaching aims to get moisture content of 0.1% (Hamm, 2003a) Finally, deodorisation is the last step and removes volatile compounds that give undesirable flavours. This will be done at high temperatures (200-220°C) and under pressure (4-10mbar) (Hamm, 2003b). After all these steps, the oil can be bottled and is suitable for human consumption.

4.3 Performance of the edible oil manufactures

CSA provides information on 259 small and 33 large and medium scale manufacturers of oils and fats (CSA, 2009d, CSA, 2010). The data suggests that the small-scale operators have a better economic performance: the capacity utilisation and the gross value of the production per person engaged is almost a quarter higher than the large and medium scale operators (Table 4.2). The processing margin is 13% of the costs of raw materials for the small-scale and 64% for the large and medium scale operators, on average 33%. This difference between small and large-medium scale might be explained by different business activities like refining, bleaching, or deodorising by large-scale operators. Another striking difference is the share of indirect taxes: small-scale operators pay a low percentage of taxes. The ratio of the gross value production divided by the total fixed assets is below 1 for the large and medium manufacturers, whereas this ratio is almost 6 for the small-scale manufacturers.

Main costs are raw materials: 89% of the production value of the small scale and 61% of the large and medium scale operators. The operating surplus is the profit plus the rents for own capital and labour. As the large and medium manufactures has a high level of fixed assets, the share is high: twice as high as for the small-scale operators.

Table 4.2	Key figures of oils and fats manufacturers in 2006/2008 (2000 E.C.)			
	Small		Large and medium	
No of establishments	259		33	
Accountancy data per average firm	ETB	%	ETB	%
Total costs of raw material	464,249	89	2,486,394	61
Cost of energy consumed	6,465	1	166,869	4
Industrial services rendered	8,832	2	64,636	2
Transport costs	996	0	36,424	1
Non-industrial services rendered	3,514	1	65,424	2
Salaries	6,491	1	354,485	9
Operating surplus	29,356	6	481,152	12
Indirect taxes	532	0	400,333	10
Gross value of production	522,445	100	4,068,696	100
Value added market price	36,369	6	1,235,939	30
Value added factor costs	36,848	6	836,485	21
Fixed assets ETB per average firm				
Non-residential buildings	44,854	50	2,160,896	45
Machinery and equipment	40,530	45	2,463,693	52
Vehicles	4,646	5	106,659	2
Others	381	0	33,310	1
Total	90,412	100	4,684,693	100
Ratios				
Number of persons engaged per firm	4.4		44.5	
Utilisation of capacity %	44.0		34.1	
Operating surplus/ Gross value production %	5.6		11.8	
Value added market price / fixed assets %	41		26	
Gross value of production/ fixed assets	5.68		0.85	
Gross value of production per person engaged in ETB	119,852		91,625	
Source: CSA (2009b), CSA (2010).				

The aforementioned oils and fats manufacturers have only a share of 12 to 13% in the domestically produced edible oil. This share can be calculated from the input and output side. The total raw material (input) costs of all manufacturers are ETBmillion 200. The farm gate price of neug or linseed is around ETB6/kg (see Chapter 6), and thus the oil manufacturers purchase around

33,000 tonnes of oil seeds. According to the FAO, Ethiopia processes 284,000 tonnes oil seeds and thus 33,000 tonnes is 12%. The output in the total gross production is ETBmillion 260. The consumer price is between ETB20 and 24/litre (Chapter 4). A price of ETB20 per litre results in a production of 13,500,000 litres. The FAO estimates a production of 92,000,000kg (= almost 100,000,000 litre), which means that the above-mentioned manufactures produce 13% of the domestic production. This is an overvalued estimate, as we have not valued the oil cake. As the formal registered manufacturers processes 12 to 13% the informal sector produces thus the remaining 87 to 88%. Furthermore, the estimated production is sufficient to supply around 1 litre/head for the urban population. The latter is 17% of the total population, of around 13m persons.

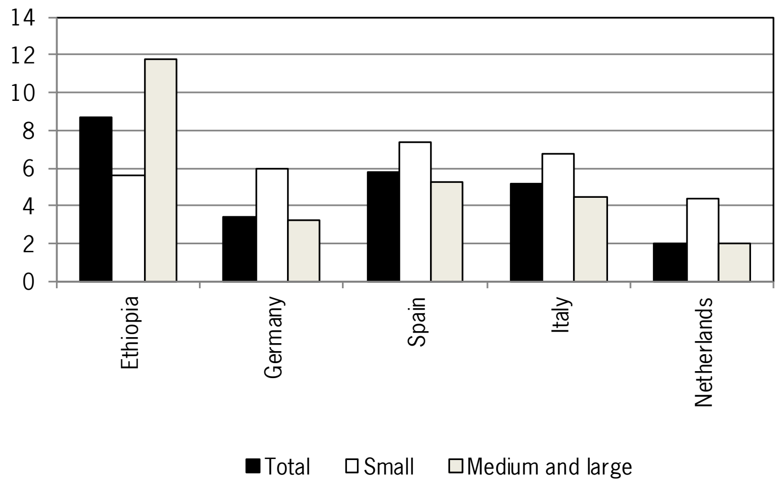
Box 4.1	**Addis Mojo**
Before 2008, this private company owned by Amibara Farm Company was a public company. It uses cotton as principal input (90%); followed by rapeseed. They have chosen to use cotton because they have a closed supply chain. They have a cotton farm in Amibara, a ginning and crushing plant in Mojo and the refinery in Addis Ababa. The extraction plant has 25% the capacity of refining plant (80 tonnes per day). They have a laboratory for analysing inputs and outputs. The factory is ISO certified.	

We benchmarked the Ethiopian economic performance with the edible oil manufacturers in the leading EU countries, representing over 80% of the total EU turnover (gross value of production). Figure 4.2 shows that the operating surplus as share of the gross value of production is remarkably high for the large and medium sized firms in Ethiopia: almost 12%. In comparison, the large and medium sized firms in the EU have a share below 6%. However, Figure 4.2 shows also that Ethiopian small-scale oil manufacturers have a similar level as the EU firms. In addition: small-scale producers in Spain and Italy have an even higher share 7.4 viz. 6.7%, compared to Ethiopian firms. In these countries many artisanal producers of olive oil exists. In Germany, the share of small-scale operators is a mere 6% and the Netherlands 1%. Appendix 6 provides some figures on the oil and fats manufacturers of the selected countries.

A remarkable fact about the Ethiopian oil manufacturers is its low level of the utilisation of the capacity (Table 4.3). This offers an opportunity as a higher utilisation level will reduce the costs, particularly the fixed costs. To explore this opportunity we assume:

- The capacity can be used at a level of 80 to 90%: this is twice the level of actual small-scale operators and 2.5 times the level of the large and medium scale operators;
- All costs increase with the same ratio, except the operating surplus. For raw materials, this means 2 viz. 2.5 times as much purchase. We assume that the prices will not change due to the higher levels of demand. The other costs will also grow with the same rate: probably a strong overestimation;
- The operating surplus will remain at the same level. This means that the actual operating surplus is a sufficient rent for capital and own labour and thus the profit will not increase.

Figure 4.2 **Gross revenue in % of turnover in Ethiopia and EU-countries in 2006 a)**



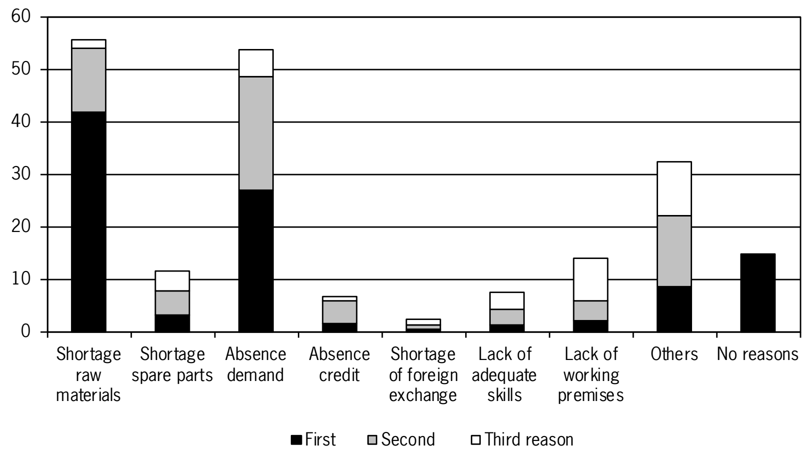
a) Small firms have between 1and 9 employees, large and medium have 10 and more employees, except for the Netherlands: small have between 1and 19 employees and large and medium have 20 and more.

The total cost per unit output will decrease with 3% for the small scale and 6% for the large and medium scale operators: on average with 5%. In case of full competition, the consumers will benefit from this higher efficiency. The price difference between imported and domestic cooking oil will be narrowed down.

Small-scale oils and fats manufacturers mention two main reasons for not working at full capacity: shortage of supplied raw materials and absence of market demand (CSA, 2010b). Figure 4.3 shows all reasons mentioned by the percentage of firms. In the survey of CSA, each establishment could mention

3 reasons in order of importance. The answered reasons are summed to get the percentage of firms that mention that specific reason. Out of 158 respondent, 88 mention foreign competition as reason for the absence of a market demand. Chapter 2 showed that a major part of the edible oil is imported and second that a major part of raw materials (sesame and neug) is exported.
We could not retrieve similar information for the large and medium scale manufacturers.

Figure 4.3 **Reasons for not working at full capacity mentioned by percentage of small-scale oils and fats manufacturers**



Source: CSA (2010b).

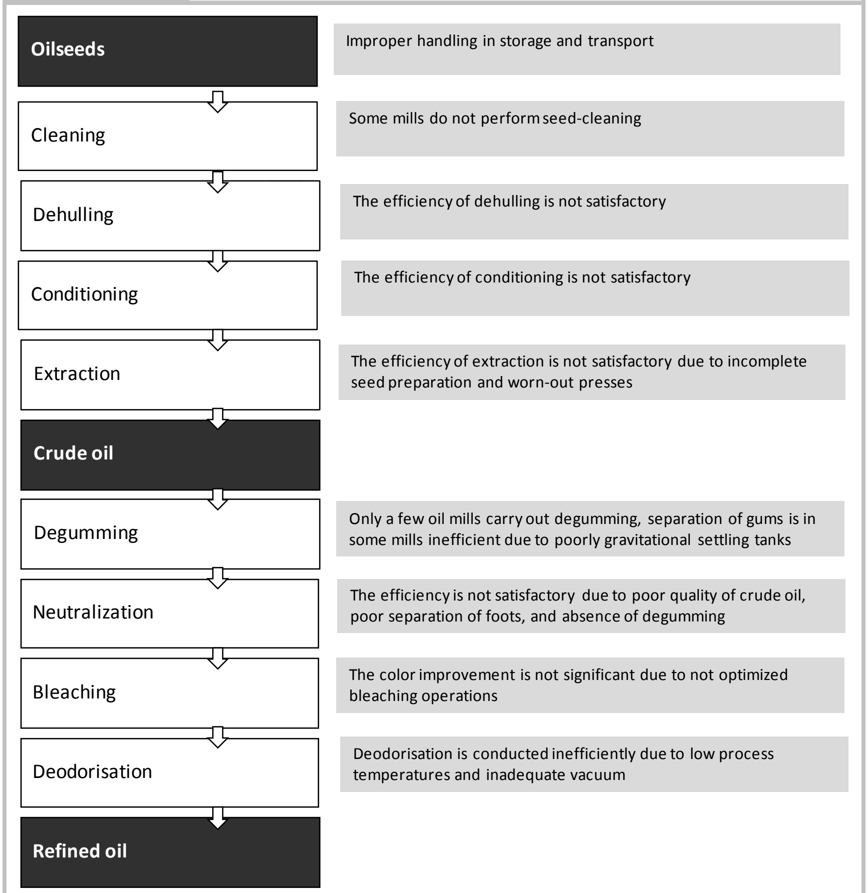
4.4 Challenges in Ethiopian oilseed processing

Ethiopian oil millers suffer from various problems(CSA, 2010, Agonafir, 2005, Eyob Tadewos, 1992, FAO, 2011). First, we present the problems based on the paper of Eyob Tadewos (1992), because that paper is rather elaborated. Second, we show that these problems still exists. Eyob Tadewos is indicates the major problems for *Ethiopian Food Corporation* (EFC) oil mills that affect the quality, process and quality control, yield, and cause refining loss. Figure 4.4 illustrated the problems in each step of production. These are:

- Most oil manufacturers use machineries that are worn-out and work inefficient.

- An underutilisation of by-products. By-products such as oilcake (animal feed) and soap stock (manufacturing of soaps) can be used for additional revenues (Eyob Tadewos, 1992).
- Extracted oils have a high impurity content resulting is a low quality. For example, linseed contains 19.9% and 16.6% impurities (in two different EFC factories, 1988-1989 EC) where 1% is maximum according the Ethiopian standards (ES.48:2001).

Figure 4.4 **Problems per step in EFC oil mills**



Source: Lute (2011).

- The quality control facilities are inadequate because of shortage in trained employees and lack of facilities.

- The low yield is a result of inefficient seed preparation that affects the extraction process. The remaining oil in the oilcake is on average 6-15% in the EFC mills; where it is normally 3-5% before solvent extraction and after solvent extraction 0.5% in sunflower cake (Hamm, 2003b).
- The refining loss and thus the refining factor is higher than on average. The refining factor is the ratio of loss at neutralisation stage to the free fatty acid content in the crude oil. For instance, in the EFC Dil factory (1988-1989) is the refining factor 12.44 for rapeseed where it is 1.9-3.8 for rapeseeds crushed in 1999-2000 reported in the Oil World Annual (Hamm, 2003b; Eyob Tadewos, 1992).

One of the recommendations of Eyob Tadewos is:

'modernising the processing method and equipment, optimising the process, and strengthening the process and quality control facilities'.

Recent studies show that Ethiopian oil millers still face these problems. The CSA reported major problems for small-scale manufactures in 2006-2008. These consists of lack of foreign currency (2.6%), lack of sufficient capital (53.3%), obstacles from governmental rules and regulations (8.2%), access to credit facilities (2.2%), lack of information (4.3%), lack of smooth supply of raw materials (14.1%), absence of adequate skills (8.2%), and others (6.1%) (CSA, 2010). Moreover, Agonafir (2005) indicates problems of unclean oil mills, backward technology resulting in a loss of oil, and problems to sell the products on the right time(Agonafir, 2005). In short, the major problems in processing of oilseeds in Ethiopia affected the quality and the yield of the oil. In 2011 the FAO reported that 60 oil processors are suspended because of mixing oilseeds or not employing proper machinery (FAO, 2011).

Ethiopia cannot export edible oil neither to the EU nor to other countries. Because the Ethiopian standards do not comply with the Codex Alimentarius and the EU has different requirements than the Codex Alimentarius. The different rules relating to criteria for the occurrence of additives, pesticides, contaminants, GMO, and erucic acid in the products, need to be applied by Ethiopian industry, before exports to the EU will be possible. Table 4.3 gives an overview of the requirements that are sufficient for export in general (follow the Codex Alimentarius), and for export particularly to the EU (follow EU requirements). Fortunately, the Ethiopian standards on hygiene, traceability, recall, and labelling are equal to the international requirements and thus can be used.

Enforcement and inspection are different for the Ethiopian standards and international requirements. Primarily, Member States can enforce the EU requirements and the *Food and Veterinary Office* (FVO) will do official controls. In contrast, most of the Ethiopian standards are not enforceable and they will serve as code of practice or guideline. However, edible oils that have an Ethiopian oil specification standard shall be marked with the Quality Mark upon approval by the QSAE; this compulsory product certification is also named as regulation enforcement. The Codex Alimentarius in contrast, provides soft law; meaning that the standards are not binding; there are no legal instruments and there is no system of justice.

Table 4.3 **Requirements for export in general and export particularly to the EU a)**

Require-ments	**Topic**	**Ethiopian standards**	**Codex Alimentarius**	**EU requirements**
Product	Additives	*ES 42:2001*	CODEX STAN 210-1999 (2009)	Regulation 1333/2008
	Pesticides	*None specific*	CAC/MRL 1 (2009)	Regulation 369/2005
	Contaminants	*ES 2820:2006*	CODEX STAN 193-1995 (2009)	Regulation 315/93, 1881/2006
	GMO	*None*	CAC/GL 45-2003 (2009)	Regulation 1829/2003
	Erucic acid	*None*	CODEX STAN 210-1999 (2009)	Directive 66/621
Process	Hygiene	ES 566:2001, ES 588:2001	CAC/RCP 1-1969 (2003)	Regulation 852/2004
	Traceability	ES 588:2001, ES ISO 22000:2008	CAC/RCP 1-1969 (2003), CAC/GL 60-2006	Regulation 168/2002
	Recall	ES ISO 22000:2008	CAC/RCP 1-1969 (2003)	Regulation 168/2002
Presentation	Labelling	ES 51:2001	CODEX STAN 1-1985 (2010)	Directive 2000/13
	Packaging	ES 51:2001		Regulation 852/2004

a) The grey cells do not meet EU requirements; the grey cells and underlined standards do not meet the Codex Alimentarius and EU requirements.
Source: Lute (2011).

4.5 Value of oil cake and raw materials in animal feed

Oil processing has two products: the main product edible oil and the by-product oil cake. The value of the oil can be derived from the prices mentioned in Chapter 3. However, the price of oil cake, a valuable animal feed, is not known. To determine the price of oil cake we compare oil cake on the energy, protein, and fat content with raw unprocessed products traditionally grown in Ethiopia and the new products soya beans and sunflower seeds (see Chapter 6). This approach is based on the farmers' choice of buying oil cake or traditional products like beans, peas, and cereals, depending on the price-value ratio. We derived a price with linear optimisation model, which is commonly used in the compound feed industry. The assumptions are:

1. The price of oil cake is the minimised price of a combination of substitute products with at least the same amount of energy (kcal), protein (g) and fat (g). This means that we neglect several attributes of these products, such as the types of amino acids, fatty acids, or digestibility of components of the products. In the compound and concentrate feed industry these other attributes are taken into account;
2. The oil cake that remains after extraction has the same protein content as raw product and the fat and energy content will be decreased with the amount of extracted oil;
3. As substitute products, we included the product and prices as selected in the farm analyses (Chapter 6) soya beans and sunflower seeds included. The latter are now scarcely available, but the aim of the research is to assess the opportunities of these new products.

It turns out that the cake price is mainly determined by the value of the raw soya beans. Table 4.4 provides the prices and the extraction rates. The extraction rates are based on the level of fat that remains in the oil cake. This level depends on the method of oil extraction: by screw presses or expellers or by solvent extraction. Ethiopia and most other developing countries use mainly screw presses. The effectiveness of the different methods is measured in the oil contents in oil cake. Oil cake from screw presses contains 10 to 15% fat, whereas the cake from solvent extraction contains approximately 1% fat (Weiss, 2000). A lower level of oil in cake means more that more oil is extracted. Edible oil has a higher economic value. Stakeholders indicated that in Ethiopia the effectiveness is 10% or higher. Therefore, we show the effects of 5, 10, and 15% fat in the oil cake. We have included neug and linseed as the oil seeds that are processed in Ethiopia. It turns out that the protein is the main ingredient that determines the prices of oil cakes and that raw soya beans determine largely the price of the oil cakes. The price of soya bean and sunflower oil cake are rather high in this respect, even higher than the price of full fat soya beans. As expected a lower percentage fat in the oil cake increase the total value of oil and cake per kg raw seeds. The value of oil cake/kg seed at the gate of the processor decreases. Less oil has been extracted and the oil cake show much more resembles with the unprocessed product at farm level.

Table 4.4 **Composition of oil cake, value cake at farm gate, and output of oil processing**

	Oil cake				Output per kg seed		
	fat	energy	protein	price at farm gate	oil	cake	value a) oil and cake
	%	kcal/100g	%	ETB/kg	g	g	ETB
Linseed	5	309	30.0	3.29	391	609	7.84
	10	339	28.5	3.12	357	643	7.33
	15	370	26.9	3.32	320	680	7.01
Neug	5	306	25.0	2.75	306	694	6.45
	10	337	23.7	3.02	267	733	6.18
	15	367	22.4	3.29	224	776	5.87
Soya beans	5	364	43.3	4.75	157	843	6.31
	10	392	41.0	4.50	110	890	5.60
	15	419	38.7	4.25	58	942	4.82
Sunflower	5	297	40.7	4.46	489	511	9.58
	10	328	38.5	4.22	461	539	9.16
	15	359	36.4	3.99	429	571	8.68
Sesame	5	297	33.5	3.67	470	530	9.29
	10	328	31.7	3.48	441	559	8.96
	15	359	29.9	3.28	408	592	8.52

a) Value at gate of the processor. See Section 7.1.2 for assumptions and approach to calculate the value of oil and cake at gate of the processor.

We could compare the price of oilcake with world market prices based on import or export prices. However, Ethiopia has a restricted import and export policy (see Section 7.4). In 2008 Ethiopia exported 100 tonnes and in 2009 600 tonnes soya bean oil cake. The received prices were far below the world average prices. It suggests that other issues (e.g. earning foreign currency) might be of more importance than a pure economic transaction. Thus, it makes no sense to compare these calculated prices with the world market prices. However, the analyses shows why Alema Koudijs (Box 4.2) buys full fatty soya beans for producing animal feed

Box 4.2	**Alema Koudijs**
This company, a partnership of Alema Agro industry (49%) and Koudijs (51%), started the operation January 2010. The installed capacity is to produce 288 ton/day, currently they are producing 96 tonnes/day animal feed. They have a formula in which 20% of the ingredients are full fat soya, because they cannot buy soya bean oil cake at an attractive price. They need around 19 tonnes soya beans per day. Every day is a struggle to reach that target. The quality of purchased seeds is improving slowly: good moisture levels and uniform seeds. They collect and evaluate samples. If the samples provided and the actual delivery has a mismatch the delivery is rejected. The cost of production has increased because of the devaluation of birr. They pay for import premix and nutritional additives and cost of freight in USD. They had to cut cost and raise the factory gate price to ETB800/100kg. They have distribution dealers in major livestock areas. (Shashemanne, Hawasa, Sodo, Sulutal, Addis Ababa) targeting commercial animal farms in urban and semi urban areas. They have not yet been able to sell to the small-scale farmers, because most people still use traditional products for feeding their animals.	

5 Middle men, traders and logistics

Key findings

- The collectors' costs of sesame seed amount to ETB56/100kg and is around 10% of the producers' value.
- The collectors' and export traders' gross margins (rent for own labour and capital) are 2-3%, the rest are direct costs.
- The exporters' costs without logistics are between ETB38 and 56/100kg
- Logistic costs are around ETB0.05/10kg/km.

The disparity between farm gate and retail price raises the all-time-question about excessive margins or profits. Almost a century ago Dunlop stated

> '…there is always a tendency, when prices are discussed, to suggest that the cost of the living is maintained at an unjustifiably high level as a consequence of the margin which the retailer demands.' (Dunlop, 1929)

Bartels (1962, cited from van Dalen, 1992) notes that

> 'The wholesale trade was considered to parasitic to society and its existence was taken to be the result of temporal inefficiencies at the sides of producers and users.'

John Stuart Mill describes trade as

> 'the mere class of distributors, whose inordinate numbers … are the cause why the portion of the wealth produced does not reach producers.'

However, middlemen, collectors, traders, wholesalers and retailers have the function to provide processors or consumers at the right time and at the right place with the right produce for a fair profit (Kohls and Uhl, 2002). Thus, these intermediaries are active between producers and consumers. The time aspect refers to the inventory and sourcing functions. Due to seasonality of agricultural production patterns and an even seasonal demand pattern for edible oil, storing products bridges the time between harvest and consumption. Furthermore, intermediaries match the differences between the production location and the place of purchase by consumers: this involves logistics. In addition, wholesalers have the function of bulking: collecting large quantities of oilseed for the processing plants. Moreover, distributors are bulk breakers and varieties assembler: providing retailers or consumers with small quantities of a large number of products. The activities of these intermediaries therefore reduce transaction costs for producers and consumers Coase states

> '… the costs of organising an activity within any given firm depend on what other activities it is engaged in. A given set of activities will facilitate the carrying out of some activities, but hinders the performance of others. It is these relationships, which undermine the actual organisation of production.' (Coase, 1972)

Intermediaries provide services in the marketing channel that enables producers to focus and to specialise. In addition to the above-mentioned functions (collecting, storing, logistics, bulk breaking, assortment assembling) they perform also functions for instance like quality control, financing stock, price negotiation, invoicing or matching supply and demand.

Information on costs of the intermediary functions is only to a limited extent publicly available. Table 5.1 provides an overview of 3 authors on sesame seed chains. Sorsa (2009) provides the marketing cost of sesame seed collectors in East Wellega, Kindie (2006) in Metema, North Gondar and Demalash (2004) in the Amhara region. The results are summarised in Table 5.1. The logistics are the main costs for the traders. The other costs of the traders are also below 10% of their purchase price. The producers' share in the export prices is still three quarter of the total export price. The costs of seeds collectors is around 10% of the purchase price of the seeds, the collectors' or export traders' gross margin is 1 to 2% of their purchase prices. These gross margins are the rents for own labour and capital; these are thus not the net-profits: profit but also losses are part of this margin.

The main outlets for producers are the local buyers, village markets and/or the local cooperatives (Sorsa Debela Gelalcha, 2009). Demalash is very clear that after cleaning the quantity that can be sold is 5% lower than the purchased quantity: Kindie is unclear in this respect. The costs of collectors range between ETB40 and ETB56/100kg. The range for the export traders is larger: between ETB88 and ETB136/100kg mainly due the forwarding costs, mentioned by Demalash. Without logistics and costs of removing impurities the costs of the wholesalers are around ETB20/100kg The traders costs without transport and forwarding provided by Kindie are 38 and by Demalash 56ETB. Stakeholders indicate transport costs from Addis Ababa to Djibouti between USD20 and 35/tonne in 2006 or ETB20 to 35/100kg, which is below the authors' indicated values. Recent information indicates indeed ETB50/100kg for that distance.

The producers' share in the export prices is still three quarters of the total export price.

Table 5.1	**Marketing costs for sesame seed in ETB/100kg**		
	Sorsa Debela Gelalcha (2009)	**Kindie Aysheshm (2007)**	**Demelash Seifu Akalewold (2004)**
Producer prices		**543.00**	**491.61**
Packing	8.38		1.00
Loading and unloading	3.00	3.00	5.00
Transport	32.46	15.00	0.00
Store rent	0.93	1.00	3.00
Tax	6.50	10.00	
Losses		15.00	9.83
Other costs	5.12		4.92
Assemblers gross margin		13.00	15.69
Total wholesale costs	56.39	56.00	39.44
Wholesale price		**600.00**	**531.15**
Loading and unloading		3.00	4.00
Transport		50.00	55.38
Forwarding			23.65
Seed cleaning		8.00	6.60
Bag		3.00	6.18
Cost impurity		10.00	12.00
Store rent		0.90	1.23
Interest		3.65	11.53
Other costs		3.15	3.66
Exporters gross margin		6.20	11.26
Total exporters cost		**88.00**	**136.61**
FOB Price (95kg)			666.86
FOB Price (100kg)		**688.00**	**603.02**

From Table 5.1 we can derive that the FOB price for sesame seed is ETB150 to ETB200 higher than the producer price. In the 2006/2008 the producer price of sesame in Tigray was ETB11.26 and in North Gondar ETB10.09/kg.

The FOB price, based on the marketing costs of Table 5.1, would then be ETB1200 to ETB1300/100kg. Thus USD135/100kg (with an exchange rate of USD1=ETB8.90) to USD160/100kg (USD1=ETB8.40). The export price of Ethiopian Sesame seed had been in 2008 had been around USD160/100kg. This means that the marketing costs indicated by Kindie and Demalash are at a realistic level.

6 Soya beans and sunflower in the cropping plan of farms

Key findings

- Opportunities for growing soya beans or sunflower seeds at farm level are assessed for the Jimma region.
- In Jimma, areas with suitable agronomic conditions for growing these new crops are available.
- Actual and 'best practice' yields with their agronomic conditions are taken into account.
- The N and P balance at farm are slightly positive in Jimma: thus sustainable soil fertility.
- At actual yield levels, soya beans and sunflowers are in the cropping plan, but contribute only marginally to the gross farm margin.
- With best practice yields the gross farm margin increase with ETB5,500/ha compared to actual yields, if sufficient credit is available
- If credit is limited, the best practice yields of a 5ha farm will have fallow land. Without credit facilities and actual yields, the 5ha farm uses all land and has a higher gross farm margin than the best practice yields farm without credit facilities.
- With a slightly higher price (less than ETB0.5/kg), soya beans are at crop rotations maximum in the plan. The gross farm margin increases also slightly with 1.4%.
- The sunflower price has to rise around ETB2.0 per kg, before being in the cropping plan. The contribution to gross farm margin is marginally.
- Soya beans and sunflowers will be in the cropping plan even with lower yields, if, due to unfavourable growing conditions, some crops are excluded.
- Soya beans have a relatively low (extractable) edible oil yield/ha compared to sunflower, linseed, and sesame seeds in Ethiopia.

6.1 Region selection and selected crops

Jimma area is selected because it has favourable growing opportunities for especially soya beans but also for sunflower seeds. As Ethiopia has different climate zones as well different agronomic conditions we selected this region to focus the analyses. Table 6.1 provides the areas and yields for the grain crops in Ethiopia and in Jimma. The selected crops in Jimma cover 91% of the total area, and are representative for all grain crops in this region. Barley, covering 5% of the grain crop are, is not included to reduce the complexity. However, wheat is selected and that crop behaves similar to barley. Barley may be helpful at lower rainfall as it has a higher drought resistance than wheat. At the same productivity and farm gate price, barley, and wheat are substitutable. So whenever wheat would be an optimal choice, also barley could be chosen. Non-grain crops like vegetables (13,800 ha in the Jimma region), root crops (6,800 ha) and fruit crops (3,600 ha) are also not selected. The area covered by these crops is small compared to other crops. We assume that these crops are mainly grown in the family vegetable garden and will not be replaced by new crops like soya bean or sunflower.

Table 6.1 **Area and yield in kg/ha of the main crop in Ethiopia and Jimma (selected crops in *italic*)**

Crop	Acronym	Ethiopia		Jimma	
		1,000 ha	1,000 tonnes	1,000 ha	ha in %
Total grain crops		**11,211**	**16,116**	**444**	**100%**
Cereals		**8,660**	**14,496**	**384**	**86%**
Teff	*Te*	*2,481*	*3,028*	*134*	*30%*
Wheat	*Wh*	*1,453*	*2,538*	*30*	*6%*
Maize	*Ma*	*1,668*	*3,923*	*116*	*26%*
Sorghum	*Sg*	*1,615*	*2,804*	*62*	*16%*
Other cereals		1,453	2,203	31	6%
Pulses		**1,585**	**1,965**	**40**	**9%**
Faba Beans	*Fb*	*539*	*696*	*24*	*5%*
Field Peas	*Fp*	*231*	*266*	*11*	*2%*
Other pulses		815	1,002	5	1%

a) Sunflower is mention in the CSA statistics, however comparing the data with previous years it looks like the data are for safflower; n.a. information not available.

Table 6.1	Area and yield in kg/ha of the main crop in Ethiopia and Jimma (selected crops in *italic*) (continued)				
Crop	**Acronym**	**Ethiopia**		**Jimma**	
		1,000 ha	**1,000 tonnes**	**1,000 ha**	**ha in %**
Oilseeds		**855**	**656**	**20**	**5%**
Neug	*Ne*	*313*	*191*	*13*	*3%*
Linseed	*Li*	*181*	*156*	*4*	*1%*
Soya beans	*So*	*6*	*8*	*n.a.*	*n.a.*
Sunflower a)	*Su*	*n.a*	*n.a.*	*n.a.*	*n.a.*
Sesame seed	*Se*	*268*	*216*	*n.a.*	*n.a.*
Other Oilseed		66	84	3	1%

a) Sunflower is mention in the CSA statistics, however comparing the data with previous years it looks like the data are for safflower; n.a. information not available.

6.2 Agronomy of crop production

6.2.1 Agronomic conditions for soya beans

Soya bean (*Glycine max* (L.) Merr) is grown from 50°S to 50°N latitude at altitudes from sea level to 2000m. The optimal daily average temperatures are between 20 and 32°C. The length of the growing season is 100 to 130 days and more. Row spacing should between 0.4 to 0.6m with 30-40 seeds per metre of row (60-80 plants/m^2). A good crop requires at least 500 mm and for maximum yield, at least 850mm is needed. Soya bean has an overall water use efficiency of about 0.4-0.6kg seed/m^3 water. With a water availability of 500mm, yields of 2,400-3,500kg/ha are possible. Water uptake and yield are reduced when water content in the soil is below 50% of field capacity. When actual evapotranspiration (the sum of evaporation and plant transpiration) is lower than the potential evapotranspiration the actual yield compared to maximum production is estimated to be maximum yield * 85% * actual/potential evapotranspiration (FAO, 2010a). Fertiliser requirements are 15-30kg/ha P and 25-60kg/ha K. The nitrogen fixation of soya bean usually can deliver about 60% of its nitrogen requirement, but with good N-fixation soya beans can grow well without N-fertiliser. However, a starter dose of 10-20kg N/ha helps the initial crop development. Continuous cropping of soya bean is not recommended. It can be grown alternatively with cotton, maize and sorghum, but to avoid build-up of crop pests longer rotations are recommended (1 in 4 years avoids build-up of crop pests/

diseases). Some bacteria may seriously reduce the yield: Pseudomonas glycine, Xanthomonas phaseoli var. Sojense, Diaporthe phaseolorum var. batatatis. Soya bean may suffer from the soya bean mosaic virus and yellow bean mosaic virus. Build-up of these bacteria, virus, and nematodes in soil and crop residues should be prevented by proper field sanitation, use of resistant varieties (root knot nematode resistance) and crop rotation are effective disease control measures. Many insects do not attack soya bean, but grasshopper, some beetles, and caterpillars may cause crop damage. Proper insect control agents should be used to prevent damage. The following *varieties* have been grown successfully in Ethiopia: Williams, Davis, Clark 63k, Coker-240, Jipoutir, T.E.M-260-22-4493, Craw ford, Hardi, Bassier, A2S2.

6.2.2 Agronomic condition for sunflower

This section provides some agronomic background of sunflower. Sunflower (Helianthus annuus L) is a member of the Asteraceae (to which also neug belongs). It is a C3-crop which is mainly grown between 20-55°N and 20-40°S latitude, in relatively cool temperate to warm subtropical climates. In Africa, cultivation is mainly limited to higher altitudes (1500-2500 m) in not too humid areas. Sunflower is not suited for high humid climates. When temperatures are below optimally below 30 °C it can be grown successfully at lower altitudes. At higher altitudes, the crop should be harvest before the onset of night frosts as these can destroy the complete crop. Sunflower needs an adequate supply of water. Seed yields of up to 2500kg/ha have been recorded in Ethiopia under rain fed conditions with more than 600 mm rainfall and up to 4000kg/ha under irrigation conditions. High rainfall (>1,000 m) will increase the risk of yield loss due to diseases and lodging. Evapotranspiration of a fast growing sunflower crop can be as high as 10-12 mm/day. The crop can withstand drought and salinity quite well, but a reduced water supply will affect yield. Assuming an average evapotranspiration of 5 mm/d and a crop cycle of 120 day, 600 mm of water should be available for maximum production. The reduction in seed yield, when actual evapotranspiration is lower than potential evapotranspiration, is about equal to the proportion of actual/potential evapotranspiration. This means for example that with a crop cycle length of 120 days only 300 mm would be available, only half the yield under no water limitation would be achieved. The water use efficiency is on average 0.3-0.5kg seed/m^3 water. So with 600 mm water available to the crop (6,000 m^3/ha) a seed yield of 1,800-3,000kg/ha is possible (FAO, 2010b). Yield reduction already starts when soil moisture content is 50% of field capacity. The actual crop cycle length will vary upon variety chosen, so also the actual water requirement depends on variety choice. Sunflower has a relatively high need of NPK: 80kg N/ha and 50kg P/ha should be applied and 25-30kg K/ha when the soil is deficient in K.

Sunflower is usually sown at the onset of the rainy season (June-July) and harvested in November-December. Sunflower usually is a short day plant (it flowers when the days shorten), but day-neutral varieties exist. A delay in sowing will reduce the length of the phase of vegetative production as it will flower (mostly) as a function of day length. Delayed planting therefore reduces the yield. With a seed rate of 4 to 10kg/ha a plant establishment should be obtained with a density of about 60,000 plants/ha with a row spacing of 0.9 m. Many field tests with sunflower have been carried out in the 1980s and 1990s and this makes the list of varieties tested in Ethiopia somewhat outdated. Traditionally, sunflower varieties grown in Ethiopia are tall growing plants. Modern varieties used in Europe and America are dwarf or semi-dwarf F1-hybrids with high yields due to increased harvest index and heterosis. Little recent information on field tests with modern sunflower varieties was found during the data collection. Some *varieties* that were successfully grown in Ethiopia are Russian Black, Hesa, Pop-158, Eliodoro, cherniankax, Gene Pool-1, Sunflower super-400. It should be noted that for an extensive introduction of sunflower in Ethiopia, more on farm experimentation is needed preferably on somewhat larger farms that have adequate access to capital for fertiliser, crop protection and improved varieties.

Pest and diseases can reduce the yield: e.g. rust (Puccinia helianthi), powdery mildew (Erysiphe cichoracearum, stem rot (Sclerotinia sclerotiorium). To combat rust, resistant varieties need to be grown, but no suitable varieties have been tested in Ethiopia as far as we know. Mildew can be treated with wetable sulphur. Stem rot should be prevented by use of non-infected seed, proper crop rotation, and hygiene (keeping field weed free, burning affected plants). Some insects might attack sunflower and proper crop protection agents should be used to treat the crop. A strict crop rotation is needed with sunflower maximally only once in 4 years and no preceding leguminous or Brassicaceae or other Asteraceae. Some of the diseases of sunflower are also affecting yields of leguminous and Brassicaceae oil crops and vice versa and/or are soil borne (e.g. Sclerotinia). Once a Sclerotinia infection occurs, the very resistant spores can remain viable in the soil for 10 years, so no Sclerotinia host should then be grown for 10 years.

6.2.3 Climate conditions and crop rotation

The selected crops (Table 6.1) show highly different optimal ranges for temperature and altitudes. In the Jimma area, conditions are found that suit all these crops. This is also apparent from the fact that agricultural statistics show that cultivation of all these crops occur in the Jimma area. It should be noted that from the statistics it could not be concluded that the all selected crops can be grown on each individual farm in the Jimma area. Conditions regarding rainfall, temperatures, and altitudes differ in the area. Therefore, it may be that conditions on individual farms only allow using subsets of these selected crops. In the analysis of optimal cropping plan, it has been assumed that a farmer in principle can grow all the selected crops. Detailed analysis of actual farms will show that in individual cases, farmers' choices are more limited. This of course may influence the optimal crop choices. When setting up value chains, such a detailed analysis is necessary on individual farm basis to check whether inclusion of sunflower or soya bean indeed is an optimal choice for a specific farmer.

Table 6.2 Climatic conditions required for selected crops

	Water requirement a)	Temperature daily averages		Acidity	Altitude		Crop cycle
		normal	absolute		normal	abso-lute	
	mm/year	°C	°C	pH	m	m	days
Teff	300-800	10-26		>6 b)	>1,000		60-150
Wheat (spring)	500-800	10-25	<35	5.5-6.5	1,800-2,800		90-115
Maize	600-900	25-30	10-35	5-8	1,000-2,400		60-200
Sorghum	500-800	25-32	15-35	5.0-8.5	<2,300		90-180
Faba beans	600-1,000	10-25	<35	6.5-6.5	2,000-3,000	1,300-3,800	90-200
Field peas c)	800-1,000	6-24	<35	5.5-6.0	1,800-3,000		90-180

a) For standard Ethiopian yields, b) But <5 possible, c) Absolute minimum water requirement 400 mm/year.
Sources: Brink et al. (2006); Van der Vossen et al. (2007); Seegeler (1983).

Table 6.2	Climatic conditions required for selected crops (continued)						
	Water requirement a)	Temperature daily averages		Acidity	Altitude		Crop cycle
		normal	absolute		normal	abso-lute	
	mm/year	°C	°C	pH	m	m	days
Soya	500-800	20-32		5.5-6.5	0-2,000		65-200
Neug	500-1,000	16-20	12-30	5.2-6.3	1,600-2,300	>500	120-180
Linseed	400-800	10-30		5.0-6.0	1,600-2,800		100-180
Sunflower	300-600	23-26	6-40	5.6-8.1	400-1,500	<2,500	65-180
Sesame	500-650	20-40		5.5-8.0	0-1,800		65-150

a) For standard Ethiopian yields, b) But <5 possible, c) Absolute minimum water requirement 400 mm/year.
Sources: Brink et al. (2006); Van der Vossen et al. (2007); Seegeler (1983).

Continuous cropping of a single crop usually results in decreasing yields over time due to build-up of soil borne pathogens and pests (nematodes, fungi, bacteria, insects) and selective depletion of (micro)nutrients. Wide rotations can prevent that. If, leguminous are incorporated in the rotation these will replenish (part of) the exported nitrogen. In our analysis of optimal crop choice - a prerequisite for determining whether (extra) inclusion of sunflower or soybean would be beneficial for a farmer - we adopted to following rotation rules:

1. No two successive years with the same cereal (each cereal <50% of farm size);
2. After two different cereals a non-cereal should be grown (total cereals <66% of farm size);
3. Leguminous once every four years;
4. Asteraceae crops (i.c. neug and sunflower) once every four years;
5. Linseed only once in two years;
6. Sunflower once in four years (and no sesame, leguminous or *Brassica* in this rotation);
7. Sesame once in four years.

This rather prudent set of rotation rules might be relaxed based on practical rotations. For example, in many parts of the world soya bean is rotated alternatively with maize, so perhaps it should be allowed to have soybean once every second year. Sunflower has been shown to perform well after some leguminous crops, so in some USA states crop rotation rules for sunflower have been relaxed. In these cases, practical data from Ethiopian experiences are needed to relax the crop rotation rules.

6.2.4 Actual and achievable yields, sowing seed and fertilisers

Actual yields, best practice yields, prices, and seed rates were found in agronomy guidelines and statistics: Table 6.3 provides an overview.

Table 6.3 **Actual (A) and best practice (BP) yields, farm gate prices (2008/2009) and seed rate**

Crop	Actual yield	Best practice yield	Farm gate price	Sowing seed
	kg/ha	kg/ha	ETB/kg	kg/ha
Teff	1,000	1,800	6.00	30
Wheat	1,400	2,600	5.00	150
Maize	2,000	4,000	3.50	30
Sorghum	1,500	2,500	3.50	15
Faba beans	1,000	2,500	4.80	185
Field peas	1,000	2,000	5.25	125
Soya	1,200	2,400	4.00	50
Neug	420	800	5.50	15
Linseed	550	1,000	5.25	35
Sunflower	700	1,400	5.25	15
Sesame	650	1,300	8.00	15

Sources: CSA (2009a); Brink et al. (2006); Van der Vossen et al. (2007) and Abebe Kirbu (2007).

The farmer can take sowing seeds from his own yields in the case of the actual yields. That means he can consume or sell less seed. He has also the option to buy seeds on the markets for 1.25 times the selling price of his own crop. In the past practice case, the farmers has always to buy sowing seed at a price 3 times the selling prices. In the best practice case, the use or crop protection agents are assumed. As we could not retrieve sufficient information on the use in terms of quantities and prices, we have included in the model (see Section 6.3) a fixed amount of ETB50/ha. This amount has been taken from (Mengistu Ketema et al., 2004).

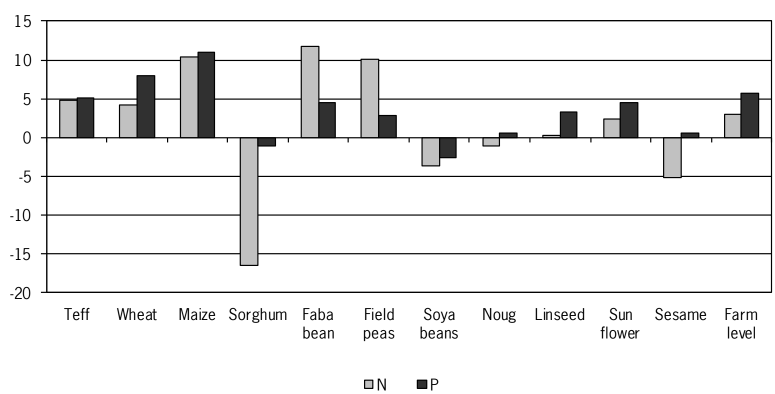
Data from CSA (2008/2009) for the Jimma region have been used to derive actual fertiliser input of N and P (CSA, 2009c). Urea and DAP use have been converted in to N and P using (0.46 N per urea and 0.208 P per DAP). K-requirement has been calculated as exported K in seed = seed yield * K-content in seed, using a recovery of 70% of K-applied. Recovery is the nutrient uptake of N and K in seed as percentage of N and K applied. The NPK-application rates for the 'best practices' farming are derived from the assumption that all exported NPK is replenished and that a recovery of 70% of N and K-applied and of 85% for P occurs For the leguminous, faba beans, field peas and soya beans, N-fixation is taken into account. The assumptions are that 70% of total N-uptake of leguminous comes from N-fixation, also thus also 70% of N-uptake in seed harvested. Therefore, with good N-fixation (prerequisite natural inoculation with Rhizobium) there is no need for N-application on leguminous to replenish export of nitrogen in seed sold. However, N fertiliser is needed to give a 'start fertilisation' and to fill in the remaining 30%. For some crops, the P-requirement with 'best practice' yields is lower than the P-use in the 'actual yields' situation, but it should be noted that in practice the P-requirement of a crop may be fulfilled on the basis of P-use on a prior crop. Therefore, higher P-use of cereals can occur while their P-requirement even in case of increased yield may be lower. For 'actual yields' the actual fertiliser use as derived from the CSA statistics. For 'best practice yields', the fertiliser requirement is determined as the amount needed to maintain soil fertility: requirement = amount exported through sales + unavoidable losses.

To determine whether current use of fertiliser is sufficient to maintain soil fertility, an indicative nutrient balance has been calculated by assuming that the nutrient export from the farm equals the amount of nutrient is seeds sold plus some losses of applied nutrients; a recovery of 70% is assumed of N and K-applied and of 85% of P-applied. Nutrient export in seed has been calculated as seed yield times the NPK-content in the seed as mentioned in Appendix 7. The N balance is defined as applied fertiliser * recovery rate + N fixation - minus yield* N-contents. The N-fixation is 70% of the total N in the yields. The P balance is the same without fixation. All balances have been calculated (for simplicity) under the assumption that all seed is sold. In reality, part of the seed is used for own consumption, and then the NPK-balances are more positive. This analysis assumes that redistribution of NPK in crop residues, manure (from use of crop residues to feed animals), and NPK excretion from human consumption to crops takes place. Figure 6.1 shows the results. The N and P balances at farm level are based on the cropping pattern in Jimma as mentioned in Table 6.1. This means e.g. that no soya beans and sunflowers are grown. An important conclusion is that sufficient N and P is applies to keep soil fertility at the actual level.

Table 6.4	Fertiliser use and required in kg N, P and K per ha					
	Actual yields			Best practice yields		
	N use a) kg/ha	P use a) kg/ha	K required kg/ha	N required kg/ha	P required kg/ha	K required kg/ha
Teff	36.3	11.1	6.5	42.6	8.6	8.6
Wheat	49.8	15.2	8.5	54.8	8.8	10.3
Maize	56.8	16.8	11.3	65.2	10.5	16.0
Sorghum	15.0	3.9	6.9	62.0	11.6	14.0
Faba beans	34.8	10.3	15.8	84.0	8.4	21.2
Field peas	30.2	8.9	15.5	64.0	9.2	20.8
Soya	24.6	6.0	30.8	116.0	14.2	35.9
Neug	15.9	4.2	3.8	29.0	6.0	6.0
Linseed	24.9	6.1	5.3	68.0	12.5	20.3
Sunflower	35.0	10.4	6.0	69.0	15.6	15.3
Sesame	19.0	5.2	5.0	45.4	9.6	6.1

a) Based on: CSA (2009c).

Figure 6.1 **N and P balance in kg/ha for the actual practice**



Highest gross extractions of nitrogen occur with leguminous, but not the highest net extractions. Faba beans and field peas contribute to a net increase in the N-status of the farm due to higher N-fixation and fertiliser application than the removal of N in seeds. Sorghum, soya beans, and sesame seeds have a negative N-balance, based on statistics and N content of the seeds. The P-fertiliser use of soya bean, sesame, and sorghum is adequate to replenish the P-export in seed; all other crops have a slight negative P balance. NPK-extractions are much higher under best practices conditions due to the higher seed yields. In the calculations of an optimal crop choice, it is assumed that nutrient requirements are fully met through adequate fertiliser application; otherwise, the best practice yields cannot be realised. Therefore, all nutrient balances are zero.

Box 6.1	**Agricultural Input Supply Enterprise (AISE)**
AISE is a public enterprise which supplies fertilisers, agro-chemicals and vegetable seeds. The government felt the supply system could jeopardise the plan for accelerated and sustainable development plan if smallholder farmers cannot access the inputs. AISE import inputs like fertilisers and crop protection agents. They also facilitate loans from government banks (Commercial Bank of Ethiopia) to Unions, who will repay after farmers have harvested. The current supply chain uses farmer cooperative unions and federations who supply to their member cooperatives and to the farmers. Seven regional centres pass the products to marketing supervisors in Woredas. Commercial farms (state and private) make their request directly to the centres who supply on per their specifications.	

6.3 Economic optimisation of crop production

6.3.1 Optimisation model

The aim of the overall research is to identify the opportunities of growing soya beans and sunflowers in Ethiopia. To achieve this goal we have to assess the possibilities and opportunities of growing these crops on farms. Growing new crops results in on-farm-competition for the limited available labour, land, and means of production. On the one hand, these new crops will thus replace actually grown crops. On the other hand, as soya beans are a leguminous, it might enhance the N-balance of the soil. In our opinion, these new crops have to improve the farm income within the agronomic and socioeconomic possibilities. We will model this situation within the framework of an agronomic and socioeconomic optimisation framework. For this complex decision problem, we developed an optimisation model in a standard linear programming approach (Schweigman, 2005; Agrawal and Heady, 1972; Barnard and Nix, 1999).

In this model, the objective function is maximising the gross return of the farm. The gross return is the sales of crops minus the cost for inputs (fertiliser, crop protection, capital), hiring manual labour, hiring oxen, buying food, buying seeds, and hiring agricultural contractors. The restrictions are available land, crop rotation, and nutrients requirements, available manual labour, available oxen labour, credit, food demand from own crops and the yield balance. The latter means that the yields of the crop can be used for own consumption, for own seed or for sale. The model and results are in detailed described by (Napol Dufera Gurmesa, 2011). We summarise the main assumptions and findings in this report. Table 6.5 present the gross return (yield * price) per ha with own labour. The labour demand for best practice is higher. Reasons are that the seedbed needs an additional tillage preparation because a softer soil is required, that higher yields require more labour for harvesting, threshing, and storing and that crop cultivation (e.g. weeding, plant protection) is at a more advance level. Accordingly, the oxen labour demand will rise as tillage and threshing require oxen labour.

Table 6.5 **Gross return (yield * price) and labour requirement per ha for actual and best practice yields**

Crop	**Gross return (ETB)**		**Man labour (hrs)**		**Oxen labour (hrs)**	
	actual	**best practice**	**actual**	**best practice**	**actual**	**best practice**
Teff	6,000	10,800	556	778	506	582
Wheat	7,000	13,000	496	694	360	414
Maize	7,000	14,000	324	454	200	230
Sorghum	5,250	8,750	396	554	262	313
Faba beans	4,800	12,000	380	532	184	212
Field peas	5,250	10,500	332	465	184	212
Soya bean	4,800	9,600	452	633	240	276
Neug	2,310	4,400	388	543	260	299
Linseed	2,888	5,250	420	588	212	244
Sunflower	3,675	7,350	322	451	248	285
Sesame	5,200	10,400	300	420	184	212

Box 6.2	Farmers' Market Organisation Hundee Gudina in Jimma
Hundee Gudina has 80 members each cultivating soya beans on 0.6ha. It markets produce from the farmers. Maize and sorghum have always been the primary crops. Soya beans are a recent introduction in the area. The dietary system of the area heavily depended on cereals. Protein from meat is very expensive and considered a luxury. This meant that the people living in the area suffered from shortage of protein in their diets. Facilitators for Change in Ethiopia (FCE), a local NGO, had ideas for introducing soya beans to solve the shortage of proteins. Soya beans are a new product for most farmers. FCE educates farmers about soya bean cultivation, its uses, and the market they could enter into in case of surplus production. Farmers who were convinced joined the cooperatives that produce and market the product. FCE provided startup money together with some money they raised internally. Productivity of soybean in the area has significantly improved over the years to its current rate of 1,400kg/ha.	

Food is commonly taking from the own crop as is shown in Section 3.8. Table 6.6 present the quantity of product taken from the own productions and the hectares needed to produce that amount. The family needs about 0.8ha with actual yields or 0.4ha with best practice yields to provide the family with own grown food. In the model, the farmer has the choice of food from own crops or by buying the same amount on the market for a 25% higher price than the sales price. Thus, the farmer can choose to grow crops that are more profitable than for own consumption.

A farmers' family consists out of 5 persons: 2 adults and 3 children. The average in Oromiya is 4.7 persons (CSA, 2006). The adults will work on the farm 8 hours during 6 days a week at the maximum. In school holidays, the children will work on the farm, in total 48 hours a week. That family has 2 oxen that can work the same amount of hours. Furthermore, we assume that a farmer has working capital of ETB250/ha, which is sufficient to buy the fertilisers. He can get credit up to a maximum of ETB2000/ha. This amount is derived from the gross margin: about 50% of that margin serves as collateral for the credit.

The model is for Meher Season: the major agricultural season for Ethiopia. In the model labour, oxen and agricultural contractors can be hired. Tractor weeding is only possible after tractor sowing. Fertiliser has to be bought and capital can be rented. Table 6.7 provides an overview of the costs and starting point.

The model maximises the gross farm margin. This margin is the sales of crops minus total cost, including the costs of food not taken from own crop. This gross margin is the rent for the labour of the farmers' family and their means of production (land, oxen, equipment). Income other than from farm activities is not included in our calculations. Expenses for family consumption other than food from own crops mentioned in Table 6.5 are not recognised in our model.

Table 6.6	**Food taken from own crops and needed ha**		
Product	**Kg**	**Ha Actual Yields**	**Ha Best Practice Yield**
Teff	250	0.250	0.139
Wheat	60	0.043	0.023
Maize	520	0.260	0.130
Sorghum	215	0.143	0.086
Faba beans	35	0.035	0.014
Field peas	15	0.015	0.008
Soya bean	5	0.004	0.002
Neug	10	0.024	0.013
Linseed	5	0.009	0.005
Sunflower	5	0.007	0.004
Sesame	5	0.008	0.004
Total		0.798	0.426

Source: CSA (2009b).

Table 6.7	**Cost of hiring, inputs, and food**	
Activity	**Unit**	**Costs**
Hiring labour	1 hour	ETB1.25
Hiring oxen	1 hour	ETB0.75
Tractor tillage	1 ha	ETB500
Tractor seed bed preparation	1 ha	ETB250
Tractor sowing	1 ha	ETB500
Tractor weeding	1 ha	ETB 65
Combine harvesting	1 ha	ETB1600
Urea	1kg	ETB2.50
DAP	1kg	ETB2.55
Interest on credit for growing season	ETB1	ETB0.1
Food	kg	1.25 times sales price
Buy seed actual farm practice	kg	1.5 times sales price
Seed 'best practice farm' (compulsory)	kg	3 times sales price
Crop protection actual farm	ha	ETB0
Crop protection 'best practice' farm	ha	ETB50

6.3.2 Impact of growing new crops in the farm income: actual yields

The lowest costs per ha are realised by a farm of 4 ha. The farms are optimised with the actual yields and without the possibility to grow soya beans or sunflowers. On smaller farms, especially on the 1ha farm the food costs are rather high. That farm needs to borrow money to buy food. On larger farms the own food consumption can be fulfilled easily, however shortage of labour and oxen results in hiring costs. In those cases, they need credit, because the working capital is not sufficient for paying the hiring costs.

Of more interest is the answer on the question 'Does growing soya beans and sunflowers improve the gross farm margin?' The answer is positive: the gross margin of the farm improves; especially for the 1 ha farm where it is improves by up to 8%. However, the contribution to a higher gross farm margin by cultivating new crops is between 18 and 38ETB/ha and thus marginal. The new crops are replacing part of the area of sesame and sorghum.

Figure 6.2 **Costs in ETB/ha for optimised farms with actual yields, without soya beans and sunflower**

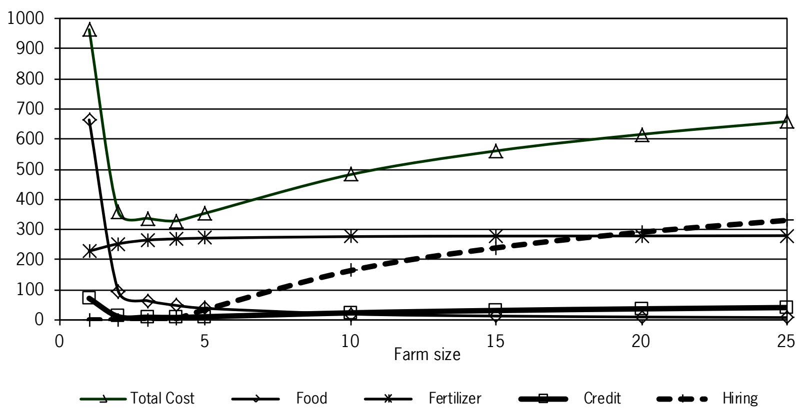
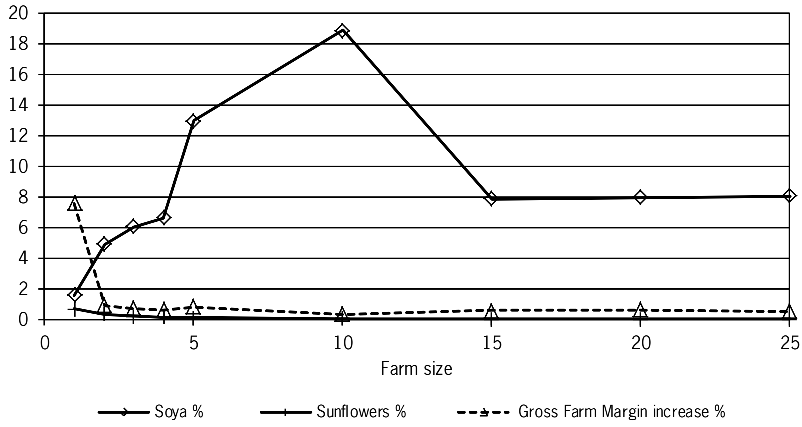


Figure 6.3	Improvement of gross farm margin (%) and new crops (%) in the cropping plan with actual yields



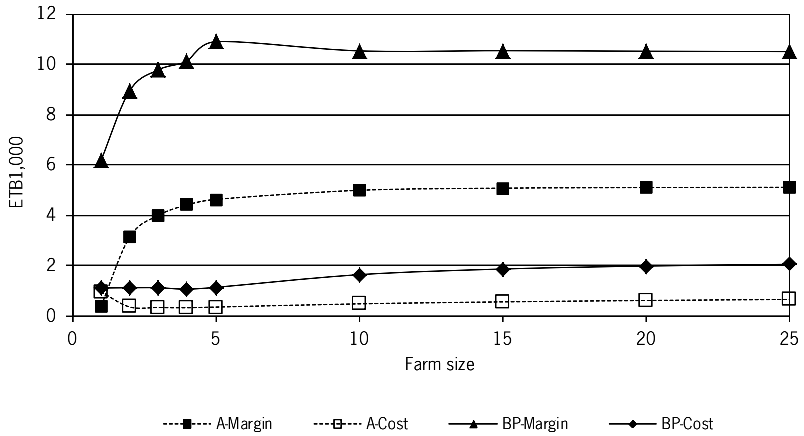
6.3.3 Impacts of best practice yields

The impact of best practice yields (Section 6.2.4) on the gross margin of the farmers is very high: it increases on for all farm size over ETB5,500/ha. The 1 ha farm has the highest benefits: a cost increase of ETB146 and the gross farm margin increases from a mere ETB400 to ETB6,200. It will be clear that the total gross farm margin differs from ETB6,200 for the 1 ha farm to ETB260,000 for the 25 ha farm. The total costs/ha increases with the farm size.

What is the contribution of the new crops? Soya beans and sunflowers are only included in the farms of 1 to 4 ha with a percentage far below 0.5%. If farms succeed in achieving the best practice yield, they will grow soya beans and sunflowers thus only marginally.

The higher yields offer opportunities for reducing the price level of products. From an economic viewpoint price will decline if the production goes up. It is expected that the assessed higher gross margin will be redistributed between farmers and consumers. As the gross farm margin is almost double, the price decline can be at the maximum around 50% at producer level. In Chapter 5 we showed that the producer share is around 75%. Assuming that the costs of intermediaries remain at the same level a price decline of 50% at producer level will be a price decline at consumer level of 35%.

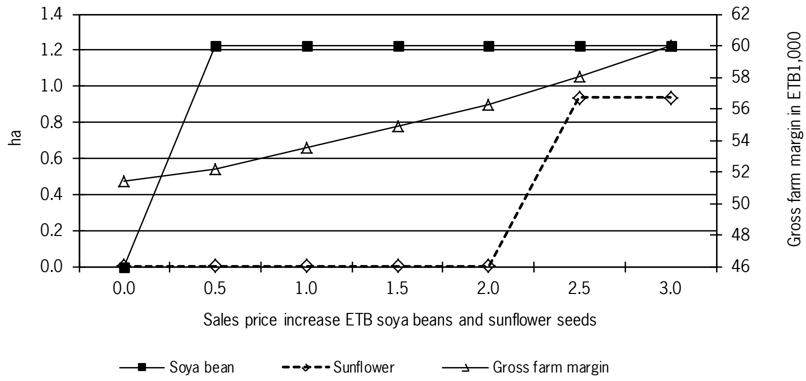
Figure 6.4 **Gross farm margin (Margin) and total cost (Cost) for actual (A) and best practice (BP) yields in ETB1,000/ha**



6.3.4 Best practice yields and price fluctuations

In the optimal plans, presented in the previous section, soya beans and sunflower are not yet in the cropping plan. We explore the consequences of prices increase. Figure 6.5 shows the acreage of soya beans and sunflower if the sales price increases. The results of the optimisation show that soya beans will be almost at the maximum of 1.25 ha in the cropping plan with only a small increase of the price (less than ETB0.5/kg). The gross farm margin increases with ETB700 (1.5%). Sunflower will be maximal in the cropping plan if the price increase is between ETB1.5 and 2.0. The additional contribution to the gross margin of sunflower with a price of ETB2 is less than ETB400 (less than 1%). In conclusion, the small changes in the gross farm margins are also a small incentive for growing these two new crops.

Figure 6.5 **Area of soya beans and sunflower and gross farm margin if sales prices increase with best practice yields**



6.3.5 Best practice yields and credit facilities

Getting credit by small holders is seen as very burdensome for small holders (Endrias Geta and Sisay Assefa, 2006, Tesfaye Letta et al., 2006, Sorsa Debela Gelalcha, 2009). Achieving best practice yields requires improved seeds, higher levels of fertilisers and crops protection and thus credit for purchasing these inputs credit. We show the impact of restricted credit facilities for the farm with 5 ha. The farm has a working capital of ETB250/ha: for this farm thus ETB1,250 in total.

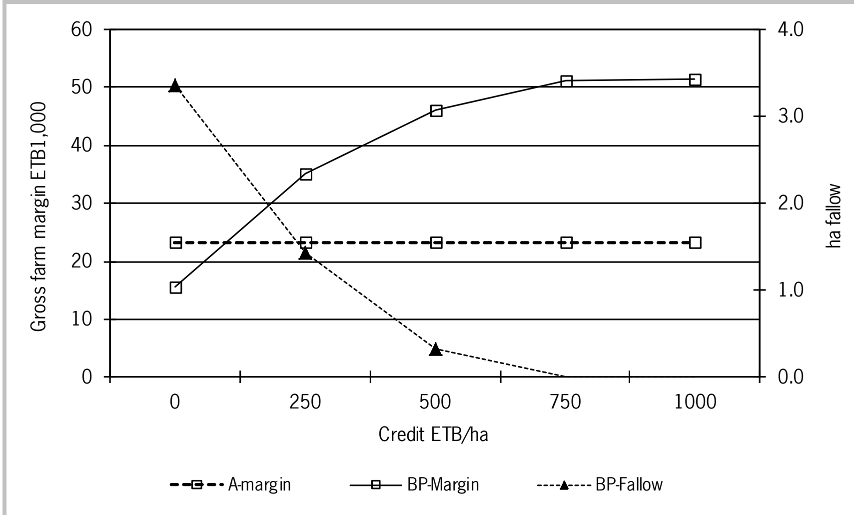
The farm with actual yields, is almost optimal without any credit, and credit is not restricting the farm plan with a credit of ETB250/ha. In the actual situation, the farm uses all land: thus no fallow land. Without credit, the gross farm return with actual yields is higher than with best practice yields. With no or a low level of credit, the farm with best practice yields uses not all the land: with no credit even 68% of the total acreage.

6.3.6 Selected crop sets and yield variation of soya beans and sunflowers

The attractiveness of growing soya beans and sunflowers depends on the competing crops and on the yield level of both crops. With the chosen crop set, farm gate prices and yield levels, soya bean and sunflower only marginally improve the farm income. However, the climate or soil conditions are not always suitable for growing all selected crops. For instance, linseed is a typical high land crop. Also in small regions, the climate can differ due to the different altitudes. To analyse the impact we restrict the crops that a farmer can grow and in the same time, we vary the yield level of the soya beans and sunflower together. In the different climate zones in Ethiopia a restricted number of crops can be grown (see Table 6.2). In the analyses, we distinguish 6 different crop sets:

1. All crops;
2. Sesame is excluded (No Se);
3. Teff, linseed and sesame are excluded (No Te, Li and Se);
4. Teff, wheat, linseed and Sesame are excluded (No Te, Wh, Li and Se);
5. Teff, wheat, linseed, sesame and sunflowers are excluded (No Te, Wh, Li, Se and Su);
6. Teff, wheat, linseed, sesame and soya beans are excluded (No Te, Wh, Li, Se and So).

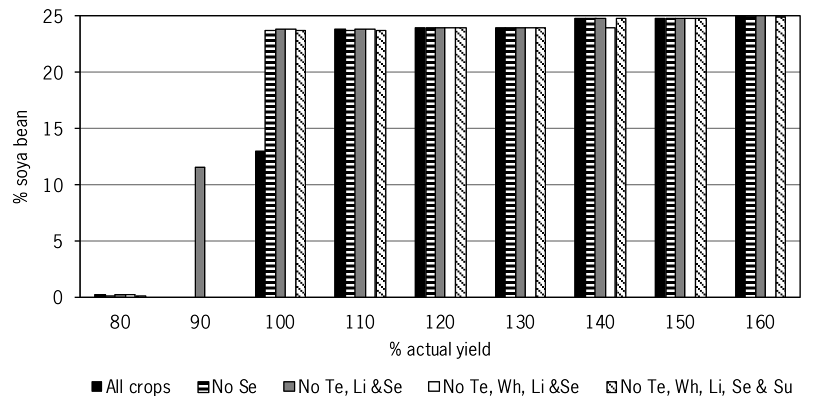
Figure 6.6 **Gross farm margin (Margin) in ETB1,000 and land used with restricted credit/ha for a farm with 5 ha with actual yields (A) and best practice yields (BP)**



Furthermore, we increased the yields of both soya beans and sunflowers together with 10% of the actual yield.

The optimal percentage soya beans is 24% (almost the maximum of 25%) with actual yield (=100%) for most crop sets except for the set with all crops. Furthermore, Figure 6.7 shows that if sesame is excluded, soya beans are in cropping plan if the yield is 90% of the actual level. Soya beans are in cropping plan in the case of all crops and the actual yield at 100%, however not at the maximum.

Figure 6.7	Percentage soya beans with different crops sets and actual yields for the 5 ha farm



Sunflower will be in the optimal cropping already with a yield level of 70%, if sesame, teff, wheat, and/or linseed are excluded. If also soya beans are excluded, the maxim percentage sunflower is reached with yield levels above 140%. Sunflowers are at the maximum for all crop sets if the yield levels are above 190%. This means that sesame compete strongly with sunflowers and second with soya beans. Furthermore, the yield increase for sunflower needs to be higher than for soya beans.

In the case of best practice yields, the results are similar with actual yields. For soya beans, the yield increase should be 10% points higher compared to the actual yields. Sunflowers will be in the cropping plan with a 10% point lower yield increase. Appendix 8 provides the figures.

6.3.7 Added value of single oilseeds in a traditional cropping plan

The contribution of oilseed to the gross farm margins depends on the chosen crop set. In this section, the contribution of each oil seed will be determined separately. For that purpose, we define first a traditional crop set. In this crops set all cereals are included (thus teff, wheat, maize and sorghum), the pulses faba beans and field peas and one oilseed neug. With the aforementioned model, we determine the gross farm margin and the farm plan. To determine the contributions of the other oilseed, we separately include just one of the other oilseeds. Figure 6.9 provides the additional gross farm margin of each crop. We solved the model again for the 5 ha farm, with actual and best practice yields. The contribution of each crop is the increase of gross farm margin compared to the margin of the traditional crop set. Except for soya beans with best practice yields, all oilseeds have a positive impact on the gross farm margin: sesame seed has the highest impact, followed by linseed. Soya beans are third in the case of the actual yields. All other oilseeds improve the gross farm margin compared to neug.

The cropping plan of the 5 ha farm is presented in Table 6.8. In all cases, cereals are grown at the maximum level, allowed by the crop rotation restriction. Soya bean replaces pulses as soya beans are in the same crop rotation set as pulses. Other oilseeds, except soya beans, replace always the traditional crop neug. Sunflowers event takes a part of the pulses area. Otherwise, the pulses, including soya beans are also at the maximum of the crop rotation rules.

Figure 6.8 **Percentage sunflowers with different crops sets and actual yields for the 5 ha farm**

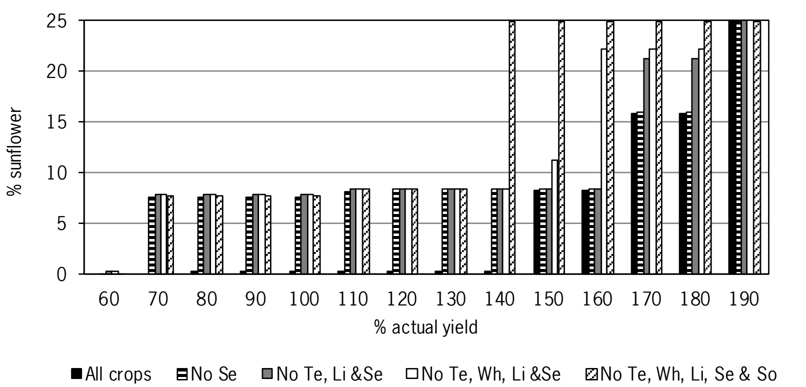


Figure 6.9 **Contribution (ETB) of each oilseed crop to the gross farm margin of 5ha farm**

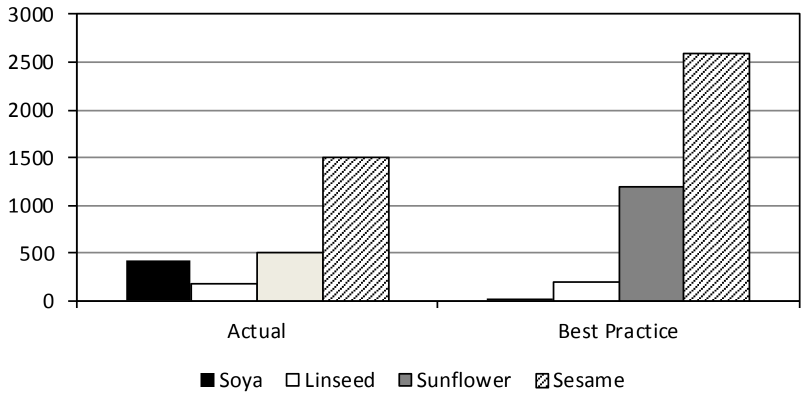


Table 6.8 **Crops shares on a 5 ha farm with a traditional crop set + a selected oilseed**

Crops	Traditional	+Soya	+Linseed	+Sunflower	+Sesame
	Actual yields				
Cereals	0.67	0.67	0.67	0.67	0.67
Faba beans and field pea	0.25	0.01	0.25	0.25	0.08
Soya		0.24			
Neug	0.08	0.08			
Linseed			0.08		
Sunflower				0.08	
Sesame					0.25
	Best practice yields				
Cereals	0.67	0.67	0.67	0.67	0.67
Faba beans and field pea	0.25	0.25	0.25	0.25	0.08
Soya		0.00			
Neug	0.08	0.08			
Linseed			0.08		
Sunflower				0.08	
Sesame					0.25

Box 6.3	Ashraf PLC

Ashraf Agricultural and Industrial PLC, an Ethiopian based company was established in 2004 by a Sudanese investor Mr. Ashraf Seed Ahmed Al-Cardinal. The company is engaged in agricultural farming, edible oil production, export abattoir and meat processing, water and juice production, plastic factory, animal feed production, animal production, and other related activities. Thus, the company is fully integrated.

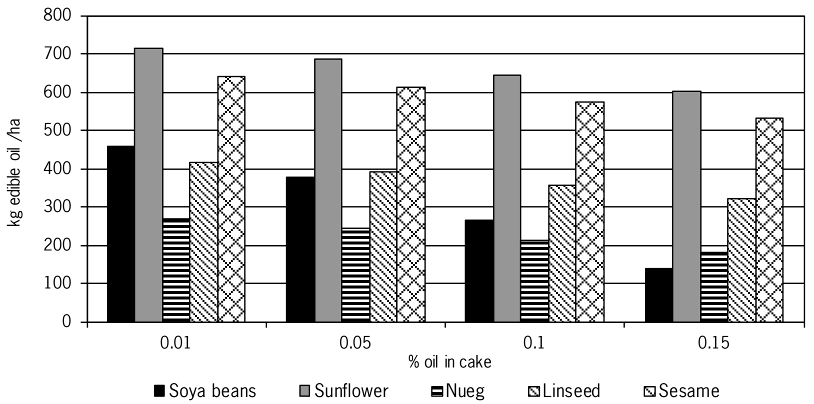
In cooperation with the Serbian Institute of Vegetable and Field Crops of Novi Sad, the company is in the process of certifying 10 high quality hybrid sunflower varieties in collaboration with the Ethiopian Institute of Agricultural Research (EIAR). Pilot tests for adaptation trial were conducted on five selected sites, namely two at Assosa, one at Pawe and two at Ginchi Research Centres. While the oil content of local sunflower varieties ranges from 28-33%, the genetic potential of the Serbian hybrids ranges between 45-51%. Other than sunflower that is meant to supply one of their edible oil factories with a capacity of producing 16,500 tonnes refined sunflower oil per annum, rotational crops such as maize, wheat, soybean and other field and vegetable crops shall be cultivated as well.

The Company is in preparation of developing 30,000 hectares of mechanised farmland around Mankush area in the Benishangul - Gumuz Regional State in the coming two years, following which the project will be expanded by an additional 40,000 ha. Once the land is acquired, it has an employment potential of over 500 permanent and 1,000 seasonal workers.

6.4 Edible oil potential per hectare of oil seeds crops.

Ethiopia has a shortage of edible oil: even with major imports, the availability for consumption is still below the Dietary Reference Intake (see Chapter 3). Whether soya beans are a good substitute for improving the edible oil balance compared to the traditional crops depends on the effectiveness of oil extraction. With a range of from 1% (only possible with hexane extraction) to 15% fat in oil cake (probably the actual practice), sunflower always achieves the highest quantity of edible oil per hectare. Figure 6.10 has been calculated using the best practice yield level. With actual yields, similar results are found, but with a level of kg edible oil per ha of around 50% of the best practice yield. With 15% fat in oil cake, all crops supply a larger quantity edible oil per hectare than soya beans. At 5 or 10% fat, this still holds for all crops except for neug that provides less than soya beans. In terms of extractable oil yield per hectare, sunflower outperforms the other oil crops. Sesame seed is second after sunflower in extractable yield per hectare. However, this crop is mainly used to export the seeds and an important foreign currency earner.

Figure 6.10	Kg extracted oil per ha based on best practice yields and % fat in oil cake



Soya beans provide more oil/ha than linseed and neug, if a solvent extraction is used with an effectiveness of 1% oil in the cake. In general, this type of extraction is capital and knowledge intensive and very large scaled. That large scale makes it hard to implement such manufacturing in Ethiopia. At this moment, only limited solvent extraction capacity is available in Ethiopia, which shows that extraction levels up to 1% oil in the cake is hardly achievable in Ethiopia. If oil pressing is the only available technology, the efficiency of soya bean extraction will be rather low. With 10% fat in cake, the extracted oil is only 11.0% of the seed weight, while in total about 19.9% of oil is present in the seed. The quantity extracted edible oil is therefore only 55% of the oil in the raw seeds. For the other oil crops, the quantities are much higher from 78% for neug to 90% for sunflowers, if oil in the cake is fixed on 10%.

7 Value chain and Key Success Factors

Key findings

- Processing of soya beans and sunflower is at least as profitable as of actual oilseeds.
- Governance between chain partners requires many efforts to establish.
- Market sustaining institutions are weak in Ethiopia.
- Sound analysis of new and expanding value chains for soya beans or sunflowers is needed as margin are small and the chain has to be organised.

7.1 Feasibility from an economic viewpoint

This section compares the domestic with import prices and the economic opportunities of processing edible oil. In Chapter 1 (Table 1.1) we showed that our approach has 4 different levels, now we focus on level 4 'Are the marginal conditions right?' The economic feasibility at farm level is extensively discussed in Chapter 6. The main conclusion is given the crop set, that soya beans can be grown from an economic viewpoint. However, the contribution to a higher gross farm margin is low: below 0.5% of the margin if no soya beans are grown. Sunflower seeds will only be grown if the price is ETB1.5 to 2.0/kg higher than the actual price. In addition, it is shown that soya beans and sunflower are in the cropping plan if sesame, teff, and/or wheat are excluded in the crop set.

7.1.1 Domestic production or import

Imported soya beans and sunflower seeds are cheaper for the processors, than domestically produced seeds. Table 7.1 provides the information based on world import prices of soya beans and sunflowers. We assume that this is also the CIF price Djibouti. The transport costs are taken from Chapter 5 (ETB0.05/ 100kg) and the traders' costs are assumed to be ETB20/100kg: in total ETB70/ 100kg for 1,000km logistics. We could not retrieve information on harbour fees and taxes. We assume that these costs are included in the logistic and traders costs. If these costs increase the import cost, the price difference with local products will be lower and vice versa. The cost at the processors' gate of domestic product is the farm gate price plus the costs of the collectors and cost or removing impurities. The collectors' costs are around ETB60/ 100kg, see

Chapter 5. The impurities costs are 2% of the value of the product (Demalash Seifu, 2004). For imported products, cleaning or bagging is not required.

The average figures show that it is cheaper for processors to import soya beans than buying at the domestic market. For sunflower seeds, we showed in Chapter 6 that this crop is not grown for that price in case all selected crops are selected. The price should then be at least ETB150/100kg higher. In that case, the average import costs are lower than the domestic costs. That means that processors will use imports from an economic viewpoint or that the price at farm level needs to be reduced. It should be noticed, that if a farmer cannot grow all crops (especially sesame) he would grow sunflowers at prices below the assumed ETB525/100kg. It is obvious that lower world market prices will not change the conclusion. Only if the world market prices are above the domestic purchase costs, farmers can grow beneficially sunflowers and/or soya beans.

Table 7.1 World import prices (2005-2009) and prices at gate processing unit

Indicator	Unit	Soya beans			Sunflower seed		
		average	min	max	average	min	max
Import							
Price a)	USD/tonne	387	269	565	592	447	875
Price	ETB/100kg	344	239	503	527	397	779
Transport and wholesaler	ETB/100kg	70	70	70	70	70	70
Price at gate processor	ETB/100kg	414	309	573	597	467	849
Domestic production							
Farm gate price	ETB/100kg	400			525		
Transport and wholesaler	ETB/100kg	60			60		
Impurities 2%	ETB/100kg	9			12		
Price at gate processor	ETB/100kg	469			597		

a) Exchange rate USD1=ETB8.9.

Import prices of edible oil by Ethiopia cannot be compared directly with domestic wholesale prices, because of lacking data of wholesale prices. Table 7.2 estimates the prices of import on wholesale level. It shows the expected price difference between palm and other oils. As the consumer price of imported oil is approximately ETB19/litre (Table 3.2), the distribution margin is approximately ETB8/litre. This margin of almost 80% of purchase price (40% of the retail price).

The wholesale price of ETB10 to 12/litre is an indication for the domestic prices. The prices of edible oil based on domestic raw materials will be higher because of the preference for specific seeds (neug, gomenezer). Furthermore the world market prices are taken for instance for sunflower and linseed. This price might be too low, as the Ethiopian import prices for soya bean and palm oil is above the average world market price.

Table 7.2	**Import prices of edible oil (average 2005-2009)**					
Indicator	**Unit**	**Soya bean**	**Palm**	**Sun-flower**	**Linseed crude**	**Linseed others**
Import price a)	USD/tonne	1,125	931	1,025	1,018	1,124
Import price b)	ETB/100kg	1,001	829	912	906	1,001
Transport and wholesaler	ETB/100kg	70	70	70	70	70
Wholesale price	ETB/100kg	1,071	899	982	976	1,071
Wholesale price	ETB/litre	12	10	11	11	12

a) The world average import prices are from UNcomtrade. For soya bean and palm oil, the Ethiopian import price is taken. The world market prices are USD789/tonne for soya bean and USD593/tonne for palm oil; b) Exchange rate USD1=ETB8.9.

7.1.2 Feasibility of the edible oil processing chain

Processing soya beans and sunflower seeds is economically feasible. We analysed the whole value chain from producer to consumer. The analysis is based on the assumption that the marginal conditions are fulfilled for neug and linseed. That means that the returns and costs are equal. Table 7.3 provides an overview of the cost and benefits. Before discussing the tentative results, we provide first the assumptions underlying the calculations. These are:

- The input (seeds) -output relation (oil and cake) is provided in Table 4.4. We take the data with 10% oil in the cake. In addition, we assume 2% impurities in the seed. That means that each 100kg raw material provides 98kg seeds for processing.
- The price of the raw materials is the farm gate price plus margin of intermediaries.
- The consumer price of oil is fixed at ETB25/litre. As the majority of edible manufacturers are located in urban region, we have taken the price at Addis Ababa (Section 3.4).
- The price of oil cake is derived in Section 4.5, Table 4.4.

- The cost of processing in Chapter 4 shows a processing margin of 11 to 39% of the costs of raw materials. With a level of 12% processing costs of the input, the marginal conditions for neug and linseed are fulfilled. These costs are also applied to the other seeds. As a result, the processing costs are ETB70/100kg input.
- Chapter 5 provides the costs of intermediaries for collecting the seeds, this is fixed at ETB70/100kg. The same costs are used for distributing the oil cake to farmers. The logistic costs are added, depending on the distance.
- The retail costs are fixed at ETB10 per litre edible oil. This is 40% of the retail price. The wholesale prices are slightly above the prices mentioned in Table 7.2. This assumption does not affect the relative position of the different oils, but are highly important for feasibility of business plans.

Table 7.3	**Costs and returns of processing 100kg raw soya beans, sunflower, neug, or linseed**					
	Unit	**Soya beans**	**Sun-flower**	**Neug**	**Linseed**	**Sesame**
Output						
Oil in cake	%	10.0	10.0	10.0	10.0	10.0
Edible oil/100kg cleaned product	kg	11.0	46.1	26.7	35.7	44.1
Oil cake/100kg cleaned product	kg	89.0	53.9	73.3	64.3	55.9
Impurities %	kg	2.0	2.0	2.0	2.0	2
Oil cake/100kg input	kg	87.2	52.9	71.8	63.0	54.8
Edible oil/100kg input	kg	10.8	45.1	26.2	35.0	43.2
Edible oil/100kg input	litre	12.0	50.2	29.1	38.9	48.0
Logistics	Birr/100kg/km	0.05	0.05	0.05	0.05	0.05
Costs						
Farm gate prices	Birr/100kg	400.00	525.00	550.00	525.00	800.00
Intermediaries	Birr/100kg	50.00	50.00	50.00	50.00	50.00
Logistics 400km	Birr/100kg	20.00	20.00	20.00	20.00	20.00
Wholesale price	Birr/100kg	470.00	595.00	620.00	595.00	870.00
Edible oil processing	Birr/100kg	70.00	70.00	70.00	70.00	70.00
Total costs	Birr/100kg	540.00	665.00	690.00	665.00	940.00

Table 7.3	Costs and returns of processing 100kg raw soya beans, sunflower, neug, or linseed (continued)					
	Unit	**Soya beans**	**Sun-flower**	**Neug**	**Linseed**	**Sesame**
Output prices						
Oil cake						
Price at farm level	Birr/100kg	474.64	445.82	274.77	329.30	347.54
Distribution costs	Birr/100kg	50.00	50.00	50.00	50.00	50.00
Logistics 200km	Birr/100kg	10.00	10.00	10.00	10.00	10.00
Price manufacturers	Birr/100kg	414.64	385.82	214.77	269.30	287.54
Edible oil						
Consumer price	Birr/litre	25.00	25.00	25.00	25.00	25.00
Distribution costs	Birr/litre	10.00	10.00	10.00	10.00	10.00
Price manufacturers	Birr/litre	15.00	15.00	15.00	15.00	15.00
Return						
Oil cake		361.47	203.92	154.23	169.61	157.59
Edible oil		180.39	752.42	436.46	583.64	719.94
Total return		541.86	956.34	590.69	753.25	877.52
Margins						
Margin =return-costs	Birr	1.86	291.34	-99.31	88.25	-62.48
Margins as % total returns	%	0	30	-17	12	-7
Margins as % processing costs	%	0	44	-14	13	-7
Margins as % farm gate price	%	0	55	-18	17	-8
Margins as % edible oil price	%	1	23	-14	9	-5

The results show that processing soya beans is just feasible, with costs equal to the returns. A small price decrease of edible oil will result in a negative margin. Sunflowers have high benefits. If these benefits are surpassed to consumers, the consumer price can go down up to 23% lower. A second option is of course increasing the farm gate prices. Table 7.3 shows that with these assumption the farm gate price can be raised with 55% or ETB2.9/kg, which is higher than the ETB2.5/kg higher price to include sunflowers in the cropping plan. If the surplus margin of processors is redistributed to farmers, sunflower cultivation is beneficially at farm level. In addition, Section 6.3.6 shows that sunflower will be in the cropping plan with assumed producer prices, if sesame seed cannot be grown. The positive margin at processor level can also be taken be the processors. However, in most countries with a competitive economy, the benefits are surpassed to consumers and in general not to producers or processors. The competitive advantage of imported oil will be lower in that case. As conclusion: an economically feasible value chain is possible for soya beans as well as for sunflowers. However, the economic benefits are marginal for soya beans, yet significant for sunflowers.

7.2 Governance and institutional barriers

Knowledge, improved inputs and improved cultivation technologies are of major importance. Without these 'advanced technologies' opportunities such as higher yields will never be exploited fully. However, the institutional environment is as important as technologies.

Institutions can be defined as the humanly devised constraints that structure political, economic, and social interactions. They consist both of informal constraints, such as customs, traditions and common norms, and formal rules, such as laws and property rights (North, 1991). Another definition emphasises the rules that are needed to facilitate the game of economic exchange: institutions are the rules of the game.

> 'Formal rules include political (and judicial) rules, economic rules, and contracts. The hierarchy of such rules, from constitutions, to statute and common laws, to specific bylaws, and finally to individual contracts defines constraints, from general rules to particular specifications.'
> (North, 1990)

The rules of the game are important for two reasons. First, well-understood rules establish baseline conditions for human interaction, and give certain predictability to what other parties will do in a particular context, that permits the actions of different individuals to be coordinated, and efficient transactional agreements to be achieved. Second, rules can serve to discourage or rule out actions that, if widely practiced, would be economically costly, and encourage actions which, if widely taken, can be productive for all (Nelson and Sampat, 2001). An important aim of institutions is to reduce uncertainty by providing a structure that guides human interaction (North, 1990). Uncertainties arise from incomplete information with respect to the behaviour of other individuals in the process of human interaction, from computational limitations of individuals, as well as from the difficulty of measuring all the attributes of a product. By constraining human action in situations of uncertainty, institutions limit the choice set of actors, support economising on information costs, and thus increase predictability of actions.

The ranking on institutions are taking from the World Bank doing business index covering the period June 2009 through May 2010 (Table 7.4). A high ranking the ease of doing business index means the regulatory environment is more conducive to the starting and operation of a local firm. The Ethiopian institutions are rather weak on registering property, getting credit, protecting investors as well as trading across borders: important institutions for new business.

Table 7.4 Ranking of Ethiopia on Doing Business Indicators

Indicator	**Rank**
Ease of Doing Business Overall	104
Starting a Business	89
Dealing with Construction Permits	53
Registering Property	109
Getting Credit	128
Protecting Investors	120
Paying Taxes	46
Trading Across Borders	156
Enforcing Contracts	56
Closing a Business	82

Source: www.doingbusiness.org/rankings 1 is the best and 183 is the worst rank.

We will not discuss exhaustively institutions and governance but we will provide only some examples from the Ethiopian agricultural to underline the importance. As these challenges are relevant for other more important crops, these are even of more importance for the very small crops sunflowers and soya beans. These challenges, lessons learned or successes factors are:

- *Inputs and financial resources*
  - Small scale farms need financial sources outside their farm to adopt new technologies, as their costs are high and farm savings rates and capital formation are meagre (Endrias Geta and Sisay Assefa, 2006).
  - The capacity to purchase input is very limited (Tesfaye Letta et al., 2006).

- Resources are very vital to facilitate adoption and dissemination of new technologies (Akalu Teshome et al., 2006).
- '… lengthy and bureaucratic processes people have to go through to obtain bank loans' (Sorsa Debela Gelalcha, 2009).
- Inadequate financial facilities to export (EPOSPEA, 2007).

- *Knowledge infrastructure*
  - Availability of technologies (Endrias Geta and Sisay Assefa, 2006).
  - Linking research and extension more closely with actual farming practice (Tesfaye Letta et al., 2006).
  - A given appropriate and accepted technology by some farmers groups, farmers-to-farmers technology transfer is the most important means of technology dissemination (Getahun Degu et al., 2006).
- *Market orientation*
  - Enhancing farmers' capacity and skills to produce for appropriate markets (Finansa et al., 2006).
  - Existence of market demand (Endrias Geta and Sisay Assefa, 2006).
  - 'Lack of access to reliable market information'(Sorsa Debela Gelalcha, 2009).
  - Lack of reliable and timely market information (Dawit Alemu and Meijerink, 2009).
- *Supply chain coordination*
  - Dedication of all partners (Endrias Geta and Sisay Assefa, 2006).
  - Without the establishment of active and strong partnership as well as a shared vision between all chain-actors the technical opportunities will also not be viable (Solomon Assefa et al., 2006).
  - Forging effective links among institutions and relevant stakeholders are of vital importance (Tesfaye Letta et al., 2006).
- *Government policies*
  - The policies for commercial transformation of Ethiopian agriculture seem to exist only on paper. The support provided and facilities required to transform the small-scale subsistence agriculture are not adequately and timely put in place (Demese Chanyalew, 2006).
  - Bureaucratic barriers at all stages of export clearance still persist (EPOSPEA, 2007).
  - Public institutions lack understanding of their mandates and the law enforcement is weak (EPOSPEA, 2007).
  - Food safety standards cannot be enforced in Ethiopia (Chapter 4).

Several issues mentioned above are addressed in the Growth and Transformation Plan. In that plan strategies are defined to enhance institutions and good governance (MoFED, 2010).

Chain governance
The number of actors in the supply chain is huge: over 10m producers of which 60,000 soya bean producers. This results also in a large number of collecting wholesalers, traders, intermediaries, or distributing wholesalers. The major market for oilseeds is Addis Ababa, counts approximately 50 main traders and over 300 wholesalers. In addition, the number of processors is in hundreds and in thousands if small-scale village crushers are added. These large numbers do not mean that the supply chain is inefficient: many actors are competing, which results in low costs. Many small holders, with a small production each, demand many chain actors downstream. Whether this atomistic structure leads to high transaction costs depends on the final market. If the final market is the local community, the transactions will be executed directly within informal constraints based on customs, tradition, and social control (Gelalcha, 2009, Sorsa Debela Gelalcha, 2009). The chain will then have only a few links. However if the final market is at a far distance and large quantities are required the transaction costs will be rather high. The long market chain is identified as a threat for the oilseed industry by EPOSPEA. Higher transaction costs result from opportunistic behaviour (EPOSPEA, 2007) and bounded rationality such uncertainty about market conditions, technology and behavioural aspects (Williamson, 1979). The chain will have many links. In the case of large quantities for a market at distance, many actors will to lead to some drawbacks:

- A low uniformity of the supply. Different growers will use different varieties and will have different agronomic conditions. Blending of such supply might be undesirable.
- Tracking and tracing will be very difficult. Product deficiencies cannot be passed to previous links in the chain. Producers will get no information to improve their product quality.

The afore-mentioned challenges show that coordination or governance between chain partners cannot easily be established. From a governance viewpoint, information on prices and partnership between chain actors is of high importance. The institutional constraints are insufficient credit facilities, weakly safeguarding property rights and trading across borders These are major threats for the actual development of the agricultural sector and of even of higher importance to develop new value chains.

7.3 Assessment of opportunities and challenges

The focus of the analysis is providing Ethiopia with a larger supply of edible oil for human consumption. We neglect the demand for proteins because we have shown in Section 2 that Ethiopia has access to a sufficient level of proteins, and these are actually consumed. Thus, we will not discuss or answer the question 'Whether products of soya beans or sunflowers fit in the Ethiopian consumption patterns'. Furthermore, we assume that the 'market' buys all oil cake from the oil processors. This means that we focus on edible oil for the domestic market as a substitute for imported palm oil. Even with this focus, the market can be segmented in e.g. the urban markets in the large cities with relatively high quality standards and rural market with direct consumers for the oil and oilseed cake.

To analyse the opportunities we will follow the standard approach from the management literature (Wright et al., 1998; Higgins and Vincze, 1993; David, 1999). The method is widely used in strategic management at firm level and less frequent for industries or sector as we do. The latter means the use of aggregated data of companies as well as macro-economic data. The consequence is that even if no opportunities are identified for the sector, individual firms with specific competencies might operate very successfully. The Strengths and Weaknesses are derived from the developments and performance of actors in the internal environment and the Opportunities and Threats (SWOT) analysis from the external environment. The threats and opportunities are the main items for analysing the external environment and are out of control for the industry. These threats and opportunities are derived from the macro-environment and the industry environment. The elements of the macro-environment are political, legal, economic, technological, and social forces, which affect the industry. An example is given to clarify the impact of the industry focus. Let us assume that the goal is achieving a higher market share on the European market. Population growth is a threat for this goal, because the domestic consumption rises and less produce is available for the foreign market. If, however, the domestic market is the focus, population growth is an opportunity because the market size is growing. The industry's strengths and weaknesses, the internal environment, have to be categorised. These issues are under control of the industry. On these issues the performance of the industry is compared with others or self-imposed standards based on the own experiences in the past. It should be an international benchmark. If industries in other countries outperform the domestic industry, the foreign industries will take over the market, unless the openness of the economy is limited. Competitive advantage refers to resources that cannot fully be duplicated by other countries. The main resources in this respect are human, organisational, and physical resources. A competitive advantage in oilseed might be a specialty oilseed (taste, fatty acid composition) which is unique on the market or a cost price below average. Abundant availability of labour of land or best practice yields, as such, are not a competitive advantages, they are an advantage if it results in a lower price or a better quality for the same price compared to the competitors. The scope of analysis is thus a comparison with the performance of the competitors on a specific market.

Strengths

- The Ethiopian agricultural sector can almost double their production, if the 'best practice' is enabled. Credits are a prerequisite for it.
- The actual farming practice is an economic sound activity, if credits are not available.
- The actual farming practice seems to be sustainable in soil fertility.
- Farmers provide their own family with food. Subsistence farming is a sound economic decision.
- Informal oil processors, mainly in the rural area, produce around 85% of all domestically produced oil.
- Producing edible oil from sunflowers is beneficially and improves the performance. Processing soya beans provides comparable economic results as the traditional seeds.

Weaknesses

- The margins on soya beans and sunflowers are generally too low for inclusion in the cropping plan. If the climate and soil conditions do not allow growing sesame, sunflower and soya beans will be in the cropping plan
- Even if soya beans are in the cropping plan, the gross farm margin increases not significantly: mainly below 0.5%.
- Import of raw soya beans and sunflowers seed is cheaper than buying domestically produced seeds for oil processors
- Large and medium scale oil processors have a poor performance.
- Formal oil processors have a market of less than 15%, mainly the urban regions
- The majority of the edible oil manufacturers have a full bookkeeping record (13 out of the 259 small and 16 out of 33 of the large and medium manufacturers (CSA, 2009d, CSA, 2010). In addition, little information on farm economics could be retrieved. This indicates that enterprises are hardly managed on economic facts.

Opportunities

- The consumption of vegetable oil and of protein in Ethiopia will rise due to the population and income growth. The domestic consumption growth is estimated to be 30 to 50%, a huge opportunity for the oilseed growers and processors in coming 10 years.
- Ethiopia has suitable climates and growing conditions for sunflowers and soybeans. However, sunflowers seeds and soybeans count each for approximately for only 1% of the Ethiopian production of oilseeds.
- The number of people in urban regions is expected to grow with 50% in 10 years' time. 17% of the 83m Ethiopians live in urban regions: the urbanisation growth of 4.3% is higher than the population growth of 3.2% (CIA, 2010). Most food processors are located in the urban region.

Threats

- Soya beans are a new crop for most farmers and edible oil producers. Introducing these new crops will increase the transaction costs and the uncertainty of finding suppliers or buyers is high. Many substitutes are available, with lower transaction costs and less uncertainty.
- The Ethiopian oil sector is in a tough competition with imported palm oil.
- Ethiopia has good substitutes for soya bean and sunflower oil.
- Credit facilities restrict implementing growing crops with best practice yields.
- The law to refine all edible is from 'food safety' viewpoint not necessary and restricts the development of the oil millers in rural areas as well as many formal oil manufacturers.
- Behaviour and lower uncertainty are not in favour to start a new value chain with soya beans or sunflower seeds.
- The institutional environment does not enhance entrepreneurship. Therefore, new value chains are not easily to establish.

Our analysis identified huge opportunities of implementing 'best practice' yields in the Ethiopian agriculture. The puzzle: 'Why are the actual yields still far below the best practice yields of field trials at farm level?' is partly solved: insufficient capital restricts the development.

However, the analysis shows no significant opportunities for establishing a soya bean or sunflower chain. Sufficient alternatives are available and embedded in the Ethiopian agricultural system to achieve equal results, with less uncertainty. This conclusion does not exclude that a group with special competencies and sufficient capital can establish a dedicated chain. An opportunity might be the 'high value Ethiopian urban markets'. Some issue to analyse are:

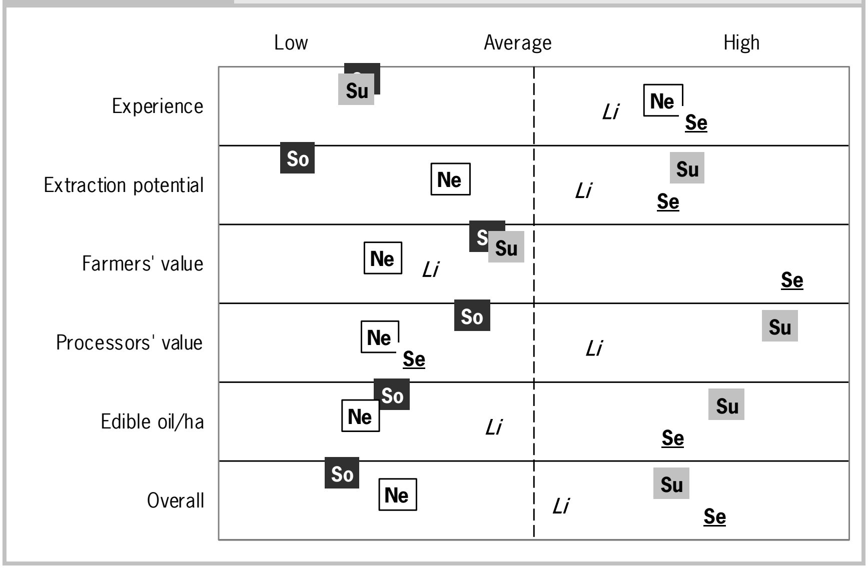
- Efficiency of the oil processing.
- A continuous supply of seeds of certain amounts and quality.
- A chain captain who can exclude actors who have a poor contract discipline and reward actors who are accepting strategic alliances.
- Lobbying to change institutions in a favourable direction. The industry has to show a shared vision about the future, have a shared strategy and a full commitment to achieve the goals.

7.4 An integrated conclusion

Sunflowers seem to offer better opportunities than soya beans. As an overall evaluation Figure 7.1 provides an overview of the main indicators for all oil seeds based on 10% oil in the cake.

It shows a strong position for sesame seed and sunflowers and a weak position for soya beans and neug.

Figure 7.1 **Economic evaluation (z-scores) of attractiveness of oil seeds value chains**



As indicators, we included:

1. *experience*

   Ethiopia grows hardly soya beans and sunflowers and thus uncertainty exists on several issues. Chain actors and especially farmers will be reluctant in growing these crops. The seed production in 2008 indicates the experience with the different crops. A high production signals that many stakeholders are involved in that specific value chain. That means that farmers have knowledge of growing these crops, that market information is available or that chain partners have knowledge to deal with these seeds.
2. *extraction potential*

   The quantity of edible oil that can be extracted depends on the oil content of the seeds and extraction effectiveness of the expellers. Many Ethiopian expellers are worn out, which results in high levels of oil in the cake. The oil content in seeds indicates the extraction potential: higher levels will result in a more attractive ratio between edible oil for consumption and oil in oil cake.
3. *farmers' value*

   From an economic viewpoint, farmers will choose crops that have the highest contribution to their income. The gross return per ha indicates the farmers' value. We took the results of the 5 ha farm with actual yields (see Section 6.3.7).
4. *processors' value*

   In addition, processors also will choose seeds that contribute most to their economic performance. The processors value is margins (return-cost) as calculated in Table 7.3.
5. *edible oil/ha*

   The Ethiopian government is aiming at improving the edible oil balance. Therefore, we included an indicator of the quantity of edible oil that can be gained from 1 ha agriculture land. This depends on the yield per ha, the oil content of the seed and the extraction effectiveness of the expellers. Section 6.4 discusses this issue and Figure 6.9 provides the data. We took the extraction rate: 10% oil in the cake and actual yields.
6. *overall*

   This indicator is the average of all aforementioned indicators.

The relative position of the oilseeds will remain almost the same if best practice yields are taken instead of actual yields.

The evaluation is based on z-scores of the variables, which means that for each indicator the average is 0 and the standard deviation is 1 (Abdi, 2007).

The z scores give the relative position of each indicator. By this standardisation, the indicators can be added to the overall indicator.

No governance or institutional indicators are included in the integrated evaluation. These indicators are the same for all crops and thus do not discriminate the selected crops.

8 Discussion

Key findings

- In 10 years' time, the population is expected to grow with one third and the consumption per head with one quarter: in total 65, more food is needed. This is a major challenge.
- Achieving 'best practice' yields for all crops enables tripling or quadrupling the oilseed and edible oil production, providing opportunities to feed a growing population, increasing exports and/or decreasing imports
- Introducing and up scaling the production of soya beans or sunflowers demands reduction of uncertainty about prices, contracts, and farm returns in the start-up phase.
- Validating the farm model with actual information of a specific group of farmers in a specific area is recommended.
- To produce 1% of the domestic edible oil demand 6,000 ha sunflowers to 15,000 ha soya beans is needed. If produced by smallholders25,000 to 60,000 farmers will be involved.
- The impact of trade policy on the supply of inputs and the export of seeds became not clear, but seems to have a strong impact.
- Last 20 years the inflation and depreciation are on a par, the last 10 years the inflation is higher than the deprecation, which results in cheaper imports.

This chapter discusses the validity and robustness of the assumptions and results presented in previous chapters.

Growing population and higher consumption is a major challenge

A major challenge is to provide the growing population with a larger quantity of food, especially fats and oil. The growth of the population is around 3%, which will result already in a demand increase of 34% in 10 years' time, if the quantity per capita remains at a constant level. The increase of fat and protein consumption per capita per year has been 2% (see Section 3.2) which results in an additional demand of 22%. These two developments combined result in a 65% higher demand for food in 10 years' time. In addition, the intake of fats and oils per capita in 2006 is far below the Dietary Reference Intake (see Table 3.1). Fully implementing 'best practices' in agriculture would double the Ethiopian agricultural production, which would be more than enough to satisfy this higher demand, however it will be a major challenge to realise this in time. The Growth and Transformation Plan recognises this:

> 'One of the major implementation strategies of the upcoming five year agriculture and rural development plan is scaling up best practices …' (MoFED, 2010)

Best practice enables higher exports and higher domestic production of edible oil

Ethiopian farm practice showed that best practice yields per ha can be twice as high as actual practice yields (see Table 6.3). The impact of realising these best practice yields outperforms by far the introduction of the new crops soya beans or sunflowers. The higher production by implementing best practices creates several opportunities. At the same time, it is possible to satisfy a higher food demand, to process a larger volume of edible oil and to increase the export of high value oil seeds. The larger exports and larger production of edible oil will increase the foreign currency earnings either by higher export earnings or by lower import costs for edible oil. By processing oil seeds domestically, the employment and domestic production will increase as well as the capacity utilisation of the edible oil manufacturers. Appendix 3 shows that around 70% of the produced oilseeds are consumed domestically and 30% is exported. If we assume that, this distribution does not change in the case of doubling the production, the export earnings, and the domestic production of edible oil double.

The gap of the higher demand and the larger production determine whether the import costs of edible oil will decrease. In 2006 the domestic edible oil production was 90,000 tonnes and the import 126,000 tonnes in total 216,000 tonnes. A demand increase of 65% means thus an additional demand of 144,000 tonnes. This amount (150% of the present production) is higher than the additional production by doubling the domestic oil production and thus a larger amount edible oil has to be imported.

Oilseeds are grown on around 8% of the total area of grain crops. If the demand for cereals and pulses grows also with 65% and best practice, yields can be realised, and area of land above the actual cultivated area with oilseeds will be available. This means that the production of oilseeds can even be tripled or even quadrupled. In the latter case, the domestic production of edible oil can be 360,000 tonnes, enough to match domestic demand.

Uncertainty about yields and contracts of the new crops

Now, Ethiopian farmers grow hardly soya beans and sunflowers. Therefore, these crops are new to many growers, intermediaries, and processors. Each chain actor has to retrieve information on prices and on finding a buyer or a seller of these products. Contact and contracts for these crops have to be established. As shown the economic benefits are marginally, which give no incentives to start a business with these crops. Participants with little own capital will avoid running the risk of low incomes by being involved in these new crops. By providing guarantees in the start-up phase, such as a gross margin per ha comparable as a substitute crop, growers will be stimulated to grow such crops. In addition, investors, who have sufficient resource for some time, can start to grow these crops. It is recommended to recognise the poor economic incentive to get involved in these crops and to mitigate the risk if these new value chains will be developed.

Soya beans and sunflowers compete with other crops in the cropping plan

In this research, the focus has been on soya beans and sunflowers. In general, the land availability is restricted for farmers. Including these new crops in the cropping plan, will result in excluding others. These excluded crops are either food crops or cash crops like sesame seed or linseed. The trade-offs are not analysed in this research. We have shown that the economic benefits are marginally. The new crops will neither improve substantially the income of farmers nor of other chain participants.

The economic and agronomic assumptions are a second issue. Small changes in the economic conditions can change the optimal cropping plan without having a significant impact on the total gross farm margin. The agronomic and the microclimate conditions in one region can differ considerable due to differences in altitudes. In our research of the Jimma region, we considered 11 crops. In practice, this number of crops that can be grown will be smaller. We recommend farm optimisation and validation for specific groups of farms. That enables to take into account on one hand the specific agronomic and economic conditions and on the other hand the preferences of the farmers.

Processors needs large quantities of raw seeds

The Ethiopian agriculture is mainly small scaled: the average farm size is below 1 ha (CSA, 2009a). As illustration to indicate the number of ha or farmers involved, we give some quantitative examples.

An edible oil producer with a capacity of 50 tonnes/week, wants to process one week only one type of seeds, with an effectiveness of 10% fat in the oil cake (see Table 7.3). For that week, he needs 455 tonnes soya beans or 108 tonnes sunflower seeds. With yields per ha the number of ha can be calculated. Due the crop restriction, soya beans or sunflowers can only be grown once in 4 years. That means that the farming area should be at least 4 times the crop area: 620 to 1,515 ha land. With an average farm of 1 ha the same number of farmers is involved, that grows the maximum levels of these crops. Table 8.1 provides the key figures. The transaction costs will be high: many contacts and contracts are needed.

Suppose that the aforementioned edible oil producer wants to use 40 weeks his full capacity (operational approximately the full year capacity) for producing only soya or sunflower oil. The production of 2,000 tonnes edible oil is approximately 1% of the total domestic demand. The area farmland needed is 25,000 to 60,000 ha. This indicates either the number of farmers involved if all raw materials will be sourced from smallholders or the area of land if an investor will produce himself the raw materials. The area of soya beans is 250% of the actual area.

These two quantitative examples indicate the efforts needed to organise the value chain with smallholders or the amount of resource needed to have an integrated value chain. In case of best practice yield, the area will be half of the mentioned levels.

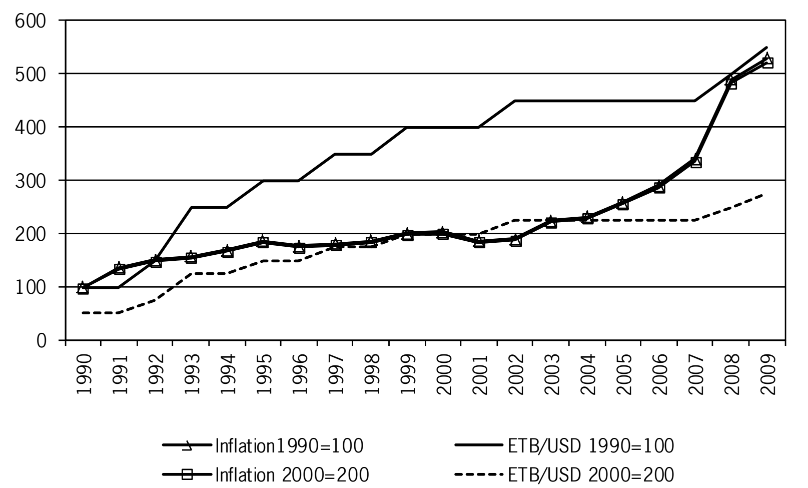
Table 8.1	**Indicators for producing 50 tonnes edible oil per week**				
Indicator	**Unit**	**1 week**		**40 weeks**	
		Soya	**Sunflower**	**Soya**	**Sunflower**
Edible oil	tonne	50	50	2,000	2,000
Oil extraction	kg/kg seed	0.110	0.461	0.110	0.461
Actual yield	tonne/ha	1.2	0.7	1.2	0.7
Input seeds	tonne	455	108	18,182	4,338
Crop area	ha	379	155	15,152	6,198
Farm land	ha	1,515	620	60,606	24,791

Government policy regarding international trade and foreign investment policy

This research did not focus on the international trade policy of the government, but stakeholders indicated that this policy has an important impact on production, imports and exports. For example, stakeholders indicated that imported oil is exempted from VAT and domestically produced is charged with VAT. Furthermore, stakeholders indicated that foreign investors would be allowed to lease (cheaply) land and receive tax holidays, if the business plan shows adequate levels of exports. This applies certainly, in case they need to import means of production like improved seed, crop protection agents, or machinery. Stakeholders also indicated that fertiliser import is government controlled and the amount supplied is insufficient. Farmers mention lack of fertiliser as one of the reasons for not adopting best practices. In this way, trade policies could hamper a development from actual yield to best practice yield levels. Finally, the government-controlled imports might hamper the growth of agricultural exports.

Last 10 years inflation higher than depreciation
Inflation and depreciation of the ETB compared to the USD complicated the research. Inflation rates in double digits since 2005 increased the domestic prices of the Ethiopian products. Feasibility of business opportunities should take into account the actual price levels, we validated our economic research on 2007/2008 data. Figure 8.1 presents the inflation and depreciation of the ETB. Last 10 years the inflation is much higher than the depreciation (lines inflation 2000=200 respectively ETB/USD 2000=200). This means that imports compared to domestic production became relatively cheaper. However, looking at a longer period (lines inflation 1990=100 respectively ETB/USD 1990=100) the gap between inflation and depreciation is closed. This means that in a 20 years period the inflation and deprecation are on a par.

Figure 8.1 **Inflation and depreciation ETB compared to USD**



Inflation lines for 1990=100 and 2000=200 overlap almost fully.
Source: WDI (consumer prices as inflation), ww.oanda.com/currency/converter/ (exchange rates at July 1st of each year).

9 Recommendations

Key findings

- Establish value chains on a shared business plan and mitigate risks.
- Focus the business plan on sunflowers.
- Explore the opportunities of soya bean oil cake for livestock.
- Link small-scale growers with large-scale growers to achieve large quantities and to reduce market uncertainties.
- Develop a strategy to achieve best practice yields.
- Exploit the system analytical framework using specific economic and agronomic data.

Establishing soya bean and sunflower value chains

We recommend organising value chains of soya beans and sunflower based on a business plan with a shared vision of all participants. In the value chain business plan attention need to be paid to the economic benefits of each participant and to the reduction of uncertainty and opportunistic behaviour. Soya beans and sunflowers offer opportunities for domestic consumption, especially for edible oil production. However, the economic benefits are marginally for al actors involved in the edible oil value chain. Establishing such, relative new value chain has to cope with uncertainty on finding buyers or sellers (contacts) and on finding the right market price (contracts). The incentives for growers or processors getting involved are therefore weak. It is recommended to reduce the uncertainty for actors, by guaranteeing economic benefits compared to the level of substitute activities. Reducing this uncertainty is crucial in starting up these chains, especially for farmers with little resources. External resources (e.g. from government or foreign development cooperation agencies) are needed to guarantee that the risk will be mitigated.

As contract-discipline and the institutional environment in Ethiopia are weak, contract enforcement demands special attention. Processors can source raw materials from other crops with very low switching costs. Farmers have little bargaining power in selling for their crop after harvesting: after sowing switching is impossible and thus the switching costs are high. It might be that traders and processors exploit the weak position of the growers.

Focussed business plans on sunflowers for scaling up
We recommend focusing on sunflower value chains. We showed that the Ethiopian menu is short in oils and fats and sufficient in proteins. Furthermore, we showed that sunflowers scored high in the economic evaluation. As sunflowers are a new crop for most farmers, knowledge will be limited available. Thus, the growers have to learn how to cultivate the crop and how the market will develop. Focus on one crop will have quicker positive results than spreading the resources over two crops.

Explore the opportunities of soya bean oil cake for livestock
The Ethiopian food supply is sufficient in proteins mainly from vegetable origin. At the same time, the consumption of animal products is low, but seems to increase in recent years. Therefore, oil cake from soya beans might contribute to a larger production of meat, eggs, or dairy. The livestock production is out of the scope of this study.

> 'Generally, the awareness of farmers of the importance of agro-industrial by-products and manufactured feed is low, resulting in low use of the products as feed.' (Berhanu Gebremedhin et al., 2009)

Furthermore, they report that only 15 feed mixers and mills exist in Ethiopia. Only 5 sell commercially and the remaining part produces for own consumption. Feed is scarce in quality and quantity. The opportunities of soya bean oil cake for livestock might improve the overall evaluation for growing soya beans. We recommend investigating the opportunities for soya bean meal in the livestock sector.

Linking small scale growers with large scale growers
Small-scale growers will use mainly traditional cultivation methods and have very limited resources to compensate failures. Failures are e.g. low or no yields, finding no buyers or low prices. As aforementioned, the possible consequences of such failures will make growers very reluctant to grow new crops.

Large-scale operators, in general large investor, have own resources. For instance, they can hire consultants, have capacity for market research and they have time to implement new crops (e.g. first variety selection before scaling up). They probably will use mechanisation for cultivation. Large-scale operators might be of interest to achieve large quantities for the processors. Outgrowers' schemes with small-scale producers might mitigate the uncertainties on finding buyers and price risks. Innovative aspects for the edible oil processors are on the economic and technical performance of extracting oil from these crops. We recommend to link small-scale grower with large-scale growers to achieve large quantities and to reduce market uncertainties.

Exploiting best practice
The results at farm level show tremendous opportunities if best practice yields can be realised. The income of farmers and the production can double. The doubled production enables at the same time a higher domestic consumption and a higher export level or lower imports. This will improve the foreign currency trade balance by higher export earnings and lower import costs. As the best practice yields are realised on field trials of research organisation and of well performing farmers, achieving these yields level is valued as very realistic. Our research identified credit facilities as a major threshold to achieve the best practice yields. We recommend developing a strategy that aims at achieving the best practice yields. In this strategy, issues to be addressed are amongst other:
- Dissemination of the opportunities and knowledge of the best practice.
- Training farmers if their knowledge is deficient.
- Credit facilities to buy inputs. As shown credit is a major constraint.
- Supply of inputs such as fertilisers, crop protection agents, and improved sowing seeds.
- A scheduled introduction of crops. Focus on the introduction of a few crops, with the highest impact.

Exploiting the system analytical framework
The analytical approaches for different chain links can be helpful to assist farmers, businesses and other actors in assessing opportunities in value chains. The approaches used in this research have two main features:
- All links in the value chain from consumer to input suppliers are analysed.
- The full system is taken into account. For instance, the new crops are evaluated within the cropping plans farmers make, taking into account agronomic and economic possibilities.

As far as we know this is the first report with an integrated analysis of the Ethiopian edible industry based on a combined approach of agronomy and new institutional economics.

The available information for the analyses turned out to be a drawback. Most information is derived from public sources providing averages of groups or regions. Information either from specific enterprises or farms or from specific regions can have large impacts on the results. Therefore, we recommend using specific data to exploit fully the presented analytical tool.

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Appendix 1

Nutrient values and weights per 100 grams edible product

Product		**Faba beans**	**Field peas**	**Soya beans**	**Sunflower**	**Sesame**	**Linseed**
Scientific name		**Vicia faba**	**Pisum sativum**	**Glycine max**	**Helianthus annuus**	**Sesamum indicum**	**Linum usitatis-simum**
Nutrient	**Unit**						
Water	g	11.0	11.3	8.5	4.6	4.6	6.0
Energy	kcal	341.0	341.0	446.0	584.0	563.0	534.0
Protein	g	26.1	24.6	36.5	20.8	16.6	18.3
Total lipid (fat)	g	1.5	1.2	19.9	51.5	49.6	42.2
Ash	g	3.1	2.6	4.9	3.0	4.5	3.6
Carbohydrate, by difference	g	58.3	60.4	30.2	20.0	23.5	28.9
Fiber, total dietary	g	25.0	25.5	9.3	8.6	11.8	26.3
Sugars, total	g	5.6	8.0	6.3	2.6	0.3	1.6
Lipids, total fatty acids							
Saturated	g	0.3	0.2	2.9	4.5	6.0	3.6
Monounsaturated	g	0.3	0.2	4.4	18.5	18.8	6.5
Polyunsaturated	g	0.6	0.5	11.3	23.1	21.8	28.6
18:2 undifferentiated	g	0.6	0.4	9.9	23.1	21.4	5.9
18:3 undifferentiated	g	0.0	0.1	1.3	0.1	0.4	22.8
Essential Amino acids							
Arginine	g	2.4	2.2	3.2	2.4	2.6	1.9
Histidine	g	0.6	0.6	1.1	0.6	0.5	0.5
Isoleucine	g	1.1	1.0	2.0	1.1	0.8	0.9
Leucine	g	2.0	1.8	3.3	1.6	1.4	1.2
Lysine	g	1.6	1.8	2.6	0.9	0.6	0.9

Sources: Food and Nutrition Board (2002), USDA (2010).

Product		Faba beans	Field peas	Soya beans	Sunflower	Sesame	Linseed
Scientific name		**Vicia faba**	**Pisum sativum**	**Glycine max**	**Helianthus annuus**	**Sesamum indicum**	**Linum usitatis-simum**
Nutrient	**Unit**						
Methionine	g	0.2	0.3	0.5	0.5	0.6	0.4
Phenylalanine	g	1.1	1.1	2.1	1.2	0.9	1.0
Threonine	g	0.9	0.9	1.8	0.9	0.6	0.8
Tryptophan	g	0.2	0.3	0.6	0.3	0.4	0.3
Valine	g	1.2	1.2	2.0	1.3	1.0	1.1
Total	g	11.4	11.0	19.3	11.0	9.5	8.9

Sources: Food and Nutrition Board (2002), USDA (2010).

Product		Saf-flower	Peanuts	Neug a)	Teff	Wheat	Maize	Sorg-hum
Scientific name		**Carthamus tinctorius**	**Arachis hypogaea**	**Guizotia abyssinca**	**Eragrostis tef**	**Triticum durum Desf.**	**Zea mays mays L.**	**Sorg-hum spp.**
Nutrient	**Unit**							
Water	g	5.6	6.5	6.0	8.8	10.9	10.4	9.2
Energy	kcal	516.0	566.0	483.0	366.0	339.0	365.0	339.0
Protein	g	16.2	25.8	16.4	13.3	13.6	9.4	11.3
Total lipid (fat)	g	38.5	49.2	34.1	2.4	2.5	4.6	3.3
Ash	g	5.5	2.3		2.4	1.8	1.2	1.6
Carbohydrate, by difference	g	34.3	16.1	36.0	63.1	61.1	64.3	64.6
Fiber, total dietary	g		8.5	13.5	8.0		6.3	6.3
Sugars, total	g		4.0		1.8		0.6	

Sources: Food and Nutrition Board (2002), USDA (2010), Bulcha (2007).
a) Source: Bulcha (2007).

Product		Saf-flower	Peanuts	Neug a)	Teff	Wheat	Maize	Sorg-hum
Scientific name		Carthamus tinctorius	Arachis hypogaea	Guizotia abyssinca	Eragrostis tef	Triticum durum Desf.	Zea mays mays L.	Sorg-hum spp.
Nutrient	**Unit**							
Lipids, total fatty acids								
Saturated	g	3.6	6.8	2.1	0.4	0.5	0.6	0.5
Monounsaturated	g	4.8	24.4	4.3	0.6	0.3	1.3	1.0
Polyunsaturated	g	28.2	15.6	26.4	1.1	1.0	2.2	1.4
18:2 undifferentiated	g	28.1	15.6	26.3	0.9	0.9	2.1	1.3
18:3 undifferentiated	g	0.1	0.0	0.1	0.1	0.0	0.1	0.1
Essential Amino acids								
Arginine	g	1.6	3.1	1.8	0.5	0.5	0.5	0.4
Histidine	g	0.5	0.6	0.4	0.3	0.3	0.3	0.2
Isoleucine	g	0.6	0.9	0.8	0.5	0.5	0.3	0.4
Leucine	g	1.2	1.6	1.2	1.1	0.9	1.2	1.5
Lysine	g	0.5	0.9	0.8	0.4	0.3	0.3	0.2
Methionine	g	0.3	0.3	0.4	0.4	0.2	0.2	0.2
Phenylalanine	g	0.8	1.3	0.9	0.6	0.6	0.5	0.5
Threonine	g	0.6	0.9	0.6	0.5	0.4	0.4	0.3
Tryptophan	g	0.2	0.3	0.3	0.1	0.2	0.1	0.1
Valine	g	1.0	1.1	1.0	0.6	0.6	0.5	0.6
Total	g	6.5	11.1	8.4	5.2	4.6	4.1	4.5

Sources: Food and Nutrition Board (2002), USDA (2010), Bulcha (2007).
a) Source: Bulcha (2007).

Appendix 2

Dietary Reference Intake

Nutrient	Unit	DRI/day for adult of 31-50 years	
		male	female
Water	g		
Energy	kcal	2400.0	2000.0
Protein	g	56.0	46.0
Total lipid (fat)	g	50.0	38.0
Ash	g		
Carbohydrate, by difference	g	130.0	130.0
Fiber, total dietary	g	38.0	25.0
Sugars, total	g		
Lipids, total fatty acids			
Saturated	g		
Monounsaturated	g		
Polyunsaturated	g	18.6	13.1
18:2 undifferentiated	g	16.0	12.0
18:3 undifferentiated	g	1.6	1.1
Essential Amino acids			
Arginine	g		
Histidine	g	0.8	0.8
Isoleucine	g	1.1	1.1
Leucine	g	2.5	2.5
Lysine	g	2.3	2.3
Methionine	g	1.1	1.1
Phenylalanine	g	2.0	2.0
Threonine	g	1.2	1.2
Tryptophan	g	0.3	0.3
Valine	g	1.4	1.4
Total	g	12.8	12.8

Sources: Food and Nutrition Board (2002), USDA (2010).

Appendix 3

Food balance of oilseeds, edible oil and pulses

Oilseeds in 1,000 tonnes

Year	Production	Import	Stock variation	Export Quantity	Domestic supply	Seed	Processing	Other utilisation	Food
1993	196	0	-18	3	165	9	152	3	11
1994	206	0	-15	10	181	10	156	3	12
1995	224	0	-20	10	194	12	165	3	14
1996	326	0	-46	15	264	9	230	3	22
1996	215	0	-1	16	198	10	161	2	14
1998	205	1	6	26	185	9	161	3	12
1999	195	0	18	38	165	10	154	3	9
2000	219	2	0	38	182	13	155	3	11
2001	269	2	-41	25	206	10	165	4	16
2002	254	1	38	86	206	12	166	3	14
2003	314	2	39	94	261	16	213	4	26
2004	493	3	-28	119	348	16	293	5	35
2005	499	4	62	263	313	16	255	4	36
2006	524	25	12	210	351	16	288	6	42
2006	530	0	-4	161	355	16	284	5	50

Source: FAOstat.

Edible oil 1,000 tonnes							
Year	**Production**	**Import**	**Stock variation**	**Export quantity**	**Domestic supply**	**Other utilisation**	**Food**
1993	43	42	0	0	85	19	66
1994	46	59	0	0	105	19	86
1995	48	49	0	0	96	31	66
1996	60	53	0	0	122	44	68
1996	50	41	0	0	91	26	63
1998	46	31	0	0	66	20	56
1999	44	51	-1	0	94	25	69
2000	44	63	-6	0	101	29	63
2001	52	68	-10	0	120	31	88
2002	50	54	6	0	111	26	83
2003	62	112	-21	0	152	56	96
2004	88	61	19	1	166	64	114
2005	86	125	-8	0	205	64	131
2006	91	94	0	0	185	66	119
2006	92	126	-21	1	196	68	129

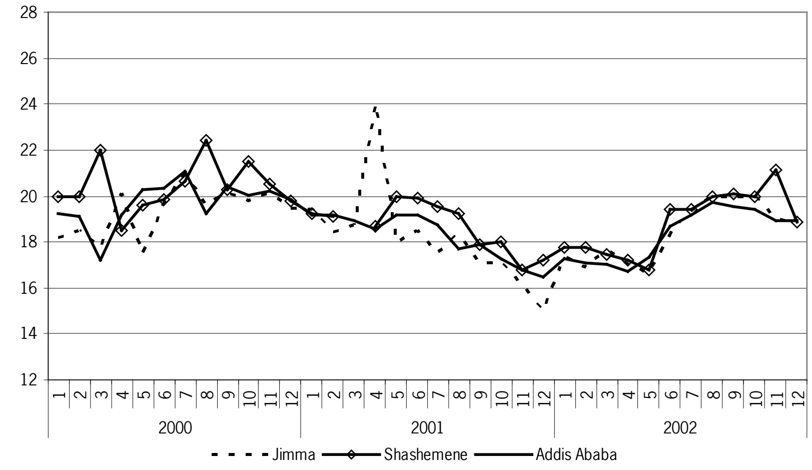
Source: FAOstat.

Pulses 1,000 tonnes								
Year	**Production**	**Import**	**Stock variation**	**Export quantity**	**Domestic supply**	**Seed**	**Other utilisation**	**Food**
1993	586	16	-15	4	584	56	31	496
1994	526	16	54	16	581	63	30	488
1995	800	6	-65	23	616	62	41	614
1996	864	5	-85	36	658	58	44	656
1996	863	5	-45	14	810	68	43	699
1998	686	5	65	24	833	63	43	626
1999	668	6	105	30	860	62	44	643
2000	996	29	-15	25	985	89	53	844
2001	1,160	20	-160	20	1,000	63	60	866
2002	1,088	3	25	100	1,016	65	58	883
2003	983	12	115	42	1,066	88	55	923
2004	1,318	25	-15	102	1,226	90	68	1,068
2005	1,320	51	25	108	1,288	82	61	1,135
2006	1,364	59	-15	126	1,293	88	64	1,131
2006	1,563	28	-15	165	1,412	96	82	1,232
Source: FAOstat.								

Appendix 4

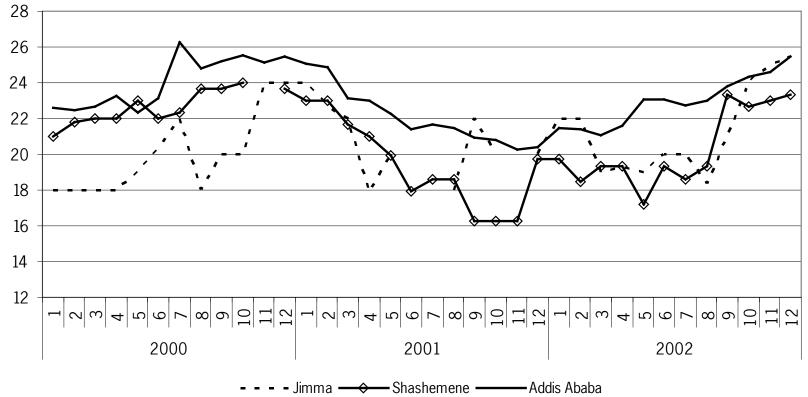
Consumer prices cooking oil

Figure A4.1 **Consumer price imported oil**



Source: www.csa.gov.et

Figure A4.2 **Consumer price local oil**



Source: www.csa.gov.et

Appendix 5

Production and utilisation of own production

Region	Crop	Production	Consumption	Seed	Sale	Wages	Feed	Other
	ton	%	%	%	%	%	%	%
Ethiopia	Cereals	144,964,059	66	16	14	1.3	0.6	3.0
	Pulses	19,646,301	61	21	15	0.8	0.3	1.9
	Oilseeds	6,556,044	53	12	29	1.3	0.1	4.6
	Neug	1,906,523	24	13	60	1.3	0.1	1.2
	Linseed	1,560,693	46	15	35	0.6	0.1	1.4
	Sesame	2,166,406	19	10	68	2.4	0.1	0.6
	Rapeseed	386,636	43	11	44	0.3	0.1	0.8
Jimma	Cereals	6,299,960	60	13	11	3.3	0.3	2.6
	Pulses	386,698	69	13	16	1.1	0.0	0.9
	Oilseeds	89,196	53	12	29	1.3	0.1	4.6
	Neug	50,632	32	15	51	0.1		0.9
	Linseed	19,669	65	13	18	2.8		0.9
	Sesame	12,066	40	4	55			0.5
	Rapeseed	1,348	65	9	25		0.5	0.3
East Shewa	Cereals	6,636,225	56	15	26	1.0	0.5	1.3
	Pulses	1,166,692	36	15	43	1.1	2.0	0.9
	Oilseeds	4,231	62	19	18	0.0	0.0	0.6
	Neug	181	30	42	23	0.0	0.0	5.0
	Linseed	1,466	56	28	15	0.0	0.0	0.0
	Sesame							
	Rapeseed	1,310	64	12	24	0.0	0.0	0.4

Appendix 6

Oil and fats manufacturers in Ethiopia and EU-countries in 2006

		Total	Small	Medium and large
Turnover % of total	Ethiopia	100	50	50
	Germany	100	4	96
	Spain	100	14	86
	Italy	100	19	81
	Netherlands a)	100	1	99
% gross revenue/turnover	Ethiopia	8.6	5.6	11.8
	Germany (2005)	3.4	10.3	3.3
	Spain	5.8	6.5	5.6
	Italy	5.2	9.6	4.1
	Netherlands	2.0	4.4	2.0
Number employees/firm	Ethiopia	8.9	4.4	44.5
	Germany	45.9	2.6	146.9
	Spain	9.4	3.1	38.0
	Italy	3.1	1.9	32.2
	Netherlands (2006)	84.9	5.4	204.2
Turnover/firm EUR million b)	Ethiopia	0.08	0.04	0.33
	Germany	54.90	2.84	166.60
	Spain	6.51	1.25	35.98
	Italy	1.49	0.29	30.24
	Netherlands (2006)	201.24	5.49	396.99

a) Small is between 1and 9 employees, large and medium is 10 and more employees, except for the Netherlands: small is between 1-19 employees and large and medium 20 and more; b) EUR1=ETB12.20 on September 1, 2006.
Source: Eurostat and CSA.

Appendix 7

NPK-contents of seeds of the selected crops

	N	P	K
	g/kg	**g/kg**	**g/kg**
Teff	21.3	4.3	4.3
Wheat	21.9	3.5	4.1
Maize	15.0	2.1	3.2
Sorghum	18.0	2.9	3.5
Faba bean	42.0	4.2	10.6
Field peas	36.0	4.6	10.4
Soya	58.0	6.1	18.0
Neug	29.0	6.0	6.0
Linseed	31.2	5.0	8.1
Sunflower	31.6	6.3	6.1
Sesame	28.4	6.0	4.4

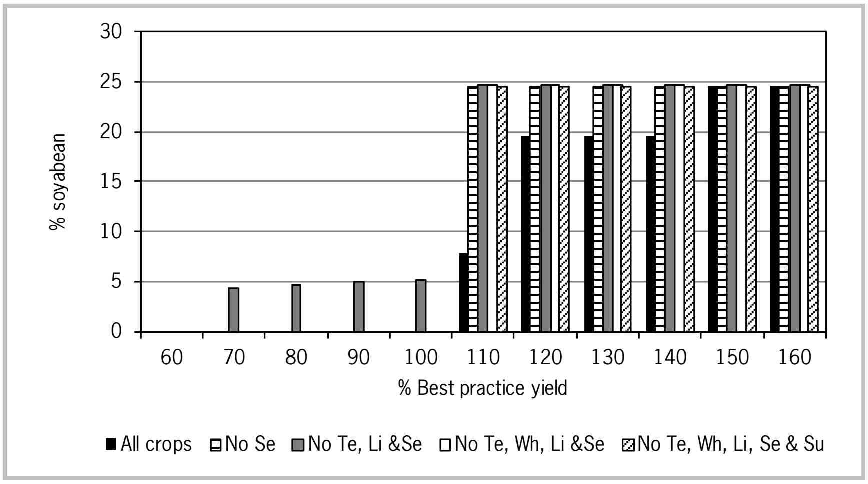
Source: Prota database and USDA (2010).

Appendix 8

Effect of crops sets and best practice yields for the 5 ha farm

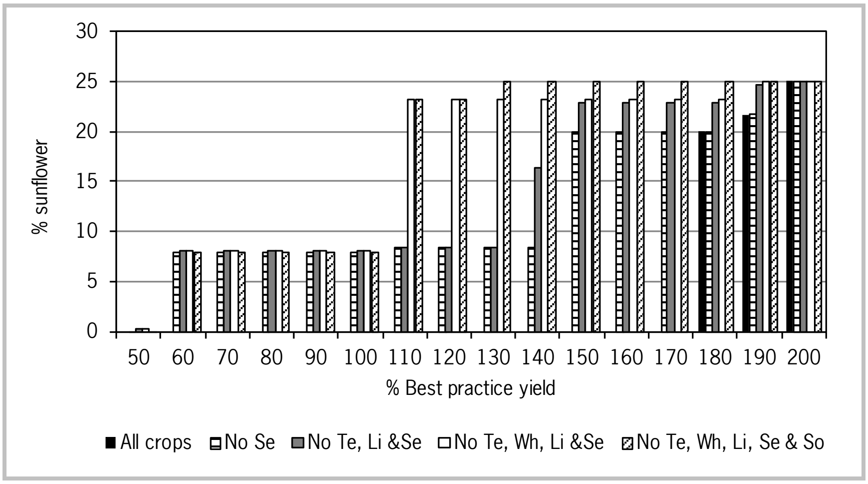
Soya beans

Optimal percentage of land allocated to soya beans with different crops sets and as a function of relative yield of soya and sunflower (% of their best practice yield) for the 5 ha farm.



Sunflowers

Optimal percentage of land allocated to sunflowers with different crops sets and as a function of relative yield of sunflower and soya (% of their best practice yield) for the 5 ha farm.



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