Handbook for Greenhouse Rose Production

Ethiopia

Ethiopian Horticulture Development Agency

Ethiopian-Netherlands Horticulture Partnership

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For quality of life

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Preface

This first version of Handbook for Greenhouse Rose Production is intended as a theoretical and practical guidebook for rose cultivation in Ethiopia and contains both background information and practical information for implementation and use in the cultivation of roses in Ethiopia. Experiences obtained during the Integrated Capacity Building Program (ICBP), the program for capacity building on management level and training of management and personnel of Ethiopian rose farms, are used in the preparation of this handbook. Additionally, this Handbook for Greenhouse Rose Production may serve as a basis for the development and implementation of manuals for practical in field trainings. Furthermore, it is intended to regularly update this handbook to keep it up to date with the latest cultivation techniques, technologies and developments within the Ethiopian rose cultivation sector.

Chapter 1 to Chapter 3 give a general introduction. Chapter 1 gives an overview of the horticultural regions in Ethiopia and the international market of roses. Chapter 2 discusses the basic aspects of the morphology and physiology of the rose plant. Chapter 3 gives insight into the management and organisation processes at farm level.

Chapter 4 to Chapter 9 are organized in such a way that first for each chapter subject the theoretic background is discussed, with subsequently information and instructions for practical implementation at farm level. In Chapter 4 the importance of record keeping and collection of data and information are explained. Chapter 5 gives an overview of greenhouse types and climate management options. Chapter 6 to Chapter 9 are concerned with subjects directly related to the cultivation of roses in Ethiopia: Chapter 6 discusses management of growing media, Chapter 7 irrigation and fertilization, Chapter 8 crop protection and Chapter 9 bush management.

Concluding, in Chapter 10 to Chapter 13 other subjects related to the cultivation of roses in Ethiopia are clarified. Chapter 10 explains about the aspects related to the requirements and demands from the market. Chapter 11 gives insight in farm economics and explains about the importance of cost price calculations. Chapter 12 elaborates about the aspects related to Corporate Social Responsibility. Concluding, Chapter 13 discusses the post harvest handling activities of cut roses and the importance of a well managed post harvest process to maintain product quality after harvest until it reaches the customer.

Additionally, several chapters have been supplemented with business cases. This is the case for Chapters 6, 7, 8, 10 and 11. The business cases give examples of experiences from practice. The business cases have be drawn up based on interviews with several representatives of Ethiopian rose farms, in which they share their practical experiences on one of the topics discussed in the corresponding chapter. The following rose farms have contributed tot the business cases and shared their experiences: Olij Roses, ET Highland Flora, Yassin Legesse Johnson Flower Farm, Tinaw Business and Dugda Floriculture.

This practical handbook is prepared by DLV Plant, in collaboration with Wageningen UR, CBI and EHPEA, under assignment of the Ethiopian Netherlands Horticulture Partnership (ENHP). The following persons have contributed to this handbook:

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Wageningen, December 2011

1 Introduction

1.1 Horticulture regions in Ethiopia

Most of the horticultural businesses in Ethiopia are located in the vicinity of Addis Ababa to access Addis Ababa's Bole International Airport. Addis Ababa has five routes that lead out of the city where horticultural farms are located, with concentration of farms in four specific regions: Ziway, Debre Zeit, Sebeta and Holeta (see figure. 1.1). In the following sections the four regions are clarified in more detail.

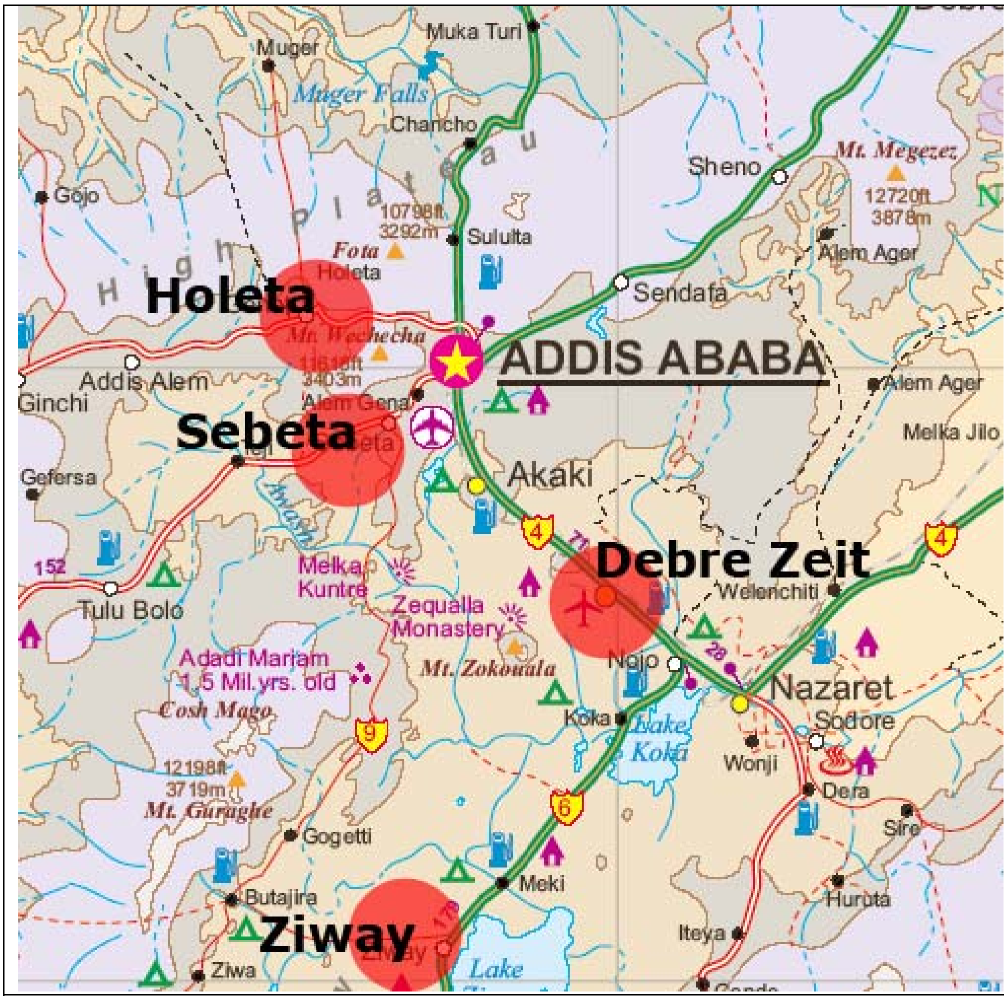


Figure 1.1: Horticultural production regions in Ethiopia

1.1.1 Ziway

The Ziway region is located at a distance of 160km to the south of the capital Addis Ababa. Horticultural production is concentrated around Lake Ziway near the town of Ziway. The lake is part of the Great Rift Valley lakes and has an open water area of 434 km^2, with a watershed area of 7300 km^2 composed of two main rivers flowing into Lake Ziway (Meki and Kera) and one river flowing out of Lake Ziway (Bulbula). The lake is the main water source for horticultural production. The climate is characterized as semi-arid to sub-humid, with an altitude of 1650m. Mean annual rainfall reaches 750mm, of which 50% is received during the wet season (Jun - Sep). Mean annual temperature is 19°C, with maxima of 29°C (Mar - May) and minima of 10°C (Dec - Jan). Several farms are also located on the way to Ziway, near Lake Koka and the town of Koka, and further to the south of Ziway near Lake Awassa.

1.1.2 Debre Zeit

The Debre Zeit region is located 50km south-east of Addis Ababa. Horticultural production is situated around the Debre Zeit town (Oromo name: Bishoftu) and its vicinity. The region is characterized by a water bearing ground layer (aquifer), from which groundwater can be extracted through artificial boreholes. Although several small lakes and rivers are located around Debre Zeit, groundwater is the main source for horticultural production. Average altitude is 1950m, mean annual rainfall reaches 900mm and the mean annual temperature is 19°C, with maxima of 29°C (Mar - May) and minima of 9°C (Dec - Jan).

1.1.3 Sebeta

The Sebeta region is located 25km south-west of Addis Ababa and horticulture farms can be found all along the road from Addis Abeba to the town of Sebeta. Groundwater (artificial borehole) is the main source for horticultural production. Average altitude at Sebeta is 2250m. Mean annual rainfall reaches 1000mm and is spread over two different seasons. Mean annual temperature is 15°C, with maxima of 24°C (Mar - May) and minima of 6°C (Dec - Jan).

1.1.4 Holeta

The Holeta region is located 30km to the west of Addis Ababa. Horticulture farms are located from around the town of Menagesha and about 25km down the main road to the west. Holeta is the largest horticultural region in Ethiopia, with about 30% of the horticultural farms located here. A regional water bearing ground layer (aquifer) is present in the region, so groundwater (artificial borehole) is the main source for horticultural production. Average altitude is 2500m. Mean annual rainfall reaches 1200mm, of which 65% is received during the wet season (Jun - Sep). Mean annual temperature is 15°C, with maxima of 25°C (Mar – May) and minima of 5°C (Dec – Jan).

1.2 International market of roses

Horticulture exports from Ethiopia are still growing and the European Union is the main destination for Ethiopian flowers. However, the European market for roses has gone through some turbulent years. The economic crisis that started at the end of 2007 has put pressure on the market, but currently there are prospects for a slow growth in the coming period. Furthermore, African growers continue to gain more market share on the European market and force local growers out of certain market segments. Nevertheless, the Dutch auctions and wholesalers continue to play a central role in European rose trade and are major consumers of roses produced in Ethiopia.

1.2.1 Development of the global flower industry

The global flower industry is a professional, dynamic and highly international industry. Trade is dominated by south-north flows with Europe and North-America housing the world's largest consumer markets, while the producing countries are situated close to the equator. During the past few decades, the industry has achieved significant growth rates. For the past ten years, the leading flower exporting countries have been the Netherlands, Colombia, Kenya, Ecuador and Israel. Since a few years, Ethiopia has joined this list, while Israel's position has weakened.

Production growth has particularly taken place in countries around the equator. Since 2004, production area in Ethiopia has grown by 1,568 hectares, Kenya has grown 1,400 hectares, Ecuador by 421 hectares and Colombia by 300 hectares. In Israel and the Netherlands, production area shrank. Given the rise in export value, the Netherlands nevertheless continue to play a key role in the international flower trade, being both the largest importer of flowers from outside the EU and the main supplier of flowers to other EU countries.

There is a general feeling that the industry faces a period of dramatic changes as it responds to the challenges posed by economic conditions. Market demand is stagnating, while supply of flowers is abundant. On the medium and long term, a moderate growth of only 2 to 4% annually is expected in Western Europe's cut flower markets. In addition, consumer demands, and subsequently trade requirements, are becoming more demanding and increasingly differentiated. Demand for sustainably produced and distributed products is rising.

As a result, margins are under pressure and playing rules are changing significantly in the flower industry. The industry is evolving towards lean and transparent supply chains. Direct trade channels, bypassing the auction system, are growing. An acceleration of technology and knowledge development is witnessed, not only in cultivation, but particularly in the way flowers are traded. Transactions are increasingly handled by means of computer systems. More than 60% of the roses traded at the FloraHolland auction are sold through the remote buying system 'KOA'. European wholesalers offer products in their own online webshop, where customers (wholesalers and retailers) can buy directly from stocks. Trade becomes virtual making accurate exchange of information critical.
Another important trend that can be noticed is the increasing relevance of social and environmental standards in the European flower trade. New patterns of consumption, media pressure, and campaigns by non-governmental organisations (NGOs) have generated consumer interest in the conditions under which flowers are produced in the developing countries. Nowadays, the market is characterised by the existence of a multitude of standards in the form of certification schemes, codes of practice and a handful of consumer labels. One of the reasons for this large number of co-existing certificates is the fact that retailers tend to adopt those standards which best meet their needs. There is even a strong trend among large retailers to set up their own private standards. So, although fragmented, the importance of standards in the European flower is increasing (see Chapter 12).
It is expected that high-tech developments and ever stricter requirements for suppliers continue in the future and will increasingly determine who is allowed to participate in these chains. Further growth of flower cultivation in Ethiopia will depend for a large part on the ability to adapt to these changing conditions.

1.2.2 The European rose market

The largest EU flower markets in terms of consumption, based on 2008 figures, are Germany (23% market share), UK (15%), France (15%), Italy (11%), the Netherlands (8%), Spain (6%), Belgium (3%) and Poland (3%).
Between 2003 and 2007, market demand for flowers remained more or less stable. Demand has only started to fluctuate in the past few years. During the second half of 2008, demand fell, as the global economic crisis struck the European Union. The effect was clearly visible as, in the period from January to April 2009, the turnover of the FloraHolland flower auction was 13% lower than in the same period in 2008. In the second half of 2009, demand started to recover from the crisis and 2010 was again regarded as a reasonably good year, based on the opinion of the surviving flower companies.

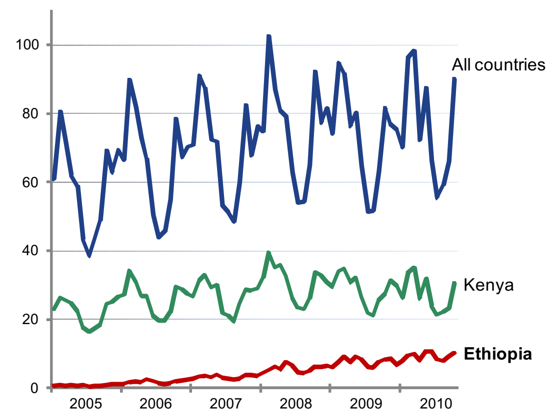


Figure 1.2: Exports to the EU in millions of euro per month (Source: Eurostat, LEI)

The global economic crisis affected demand in all EU countries, but to different degrees. Most remarkable was that most former growth markets were hit particularly hard. These markets included the United Kingdom (UK), Spain, Greece and Ireland. On the medium and long term, a slow growth of 2 to 4% annually is still expected in Western Europe's cut flower markets. Emerging markets, such as East European countries, are expected to make a particularly significant contribution to the long-term growth in total European consumption. In Ethiopia, the hard times floored some companies, but also produced a seasoned export sector whose impressive growth since 2000 can no longer be passed off as a fluke. Ethiopia now holds a firm position among the Top 5 European suppliers – along with Kenya, Ecuador,

Table 1.1: Roses traded at the Dutch auctions 2008-2010

	Supply (*in million stems*)		
	'08	**'09**	**'10**
Roses Large	2,718	2,592	2,524
- *imported*	1,640	1,478	1,321
- *Netherlands*	1,078	1,114	1,203
Roses Small	839	854	891
- *imported*	822	831	859
- *Netherlands*	17	23	32
Roses Spray	85	63	69
- *imported*	49	27	28
- *Netherlands*	36	36	41

(Source: ITC Market News Service, 2011)

Colombia and Israel – and an impressive second place among Dutch auction suppliers. The share of Ethiopian flowers in European imports doubled from 6% in 2005 to 12% in 2010. Statistics suggest Ethiopia is steadily catching up on Kenya.

The Netherlands accounts for roughly 60% of total European rose imports. The auctions play a particularly important role. In 2010, 3.7 billion roses were traded at the Dutch auctions, representing about € 750 million. Dutch export wholesalers supply roses to all corners of the European Union. In the past decade, they have actually gained market share in many European countries, at the cost of local wholesalers. Already two thirds of the roses auctioned by FloraHolland are imported. Due to the competition from African growers, many Dutch rose growers were forced to stop growing roses or have specialised in red and white large-budded varieties, which are more difficult to transport. Still, the number of Dutch roses sold at the auctions managed to grow thanks to increasing scales and productivity.

1.2.3 How markets operate

Ethiopian roses can follow different routes to the European end consumer. A variety of players can be involved in handling the roses (see figure 1.3):

1 *Through the auction:* The import division of the auction itself receives the roses and unpacks and prepares the product for auctioning.

2/3 *Through an import agent to the auction or to a wholesaler:* Products are received by an agent who either prepares the products for auctioning or directly sells the products to a European wholesaler. Agents also spread a shipment over several auction days to insure a continuous supply to the auction clock.

4 *Directly to an importing wholesaler:* The roses are bought by a wholesaler who further processes them (for instance preparing bouquets) and sells to domestic and foreign wholesalers and retailers.

5 *Directly to a retailer:* Products are imported directly by a retailer. In most cases this involves an import division of a large supermarket chain.

In case of routes 1 and 2, roses pass through the auction system. Routes 3, 4 and 5 bypass the auctions and are classified as direct trade.

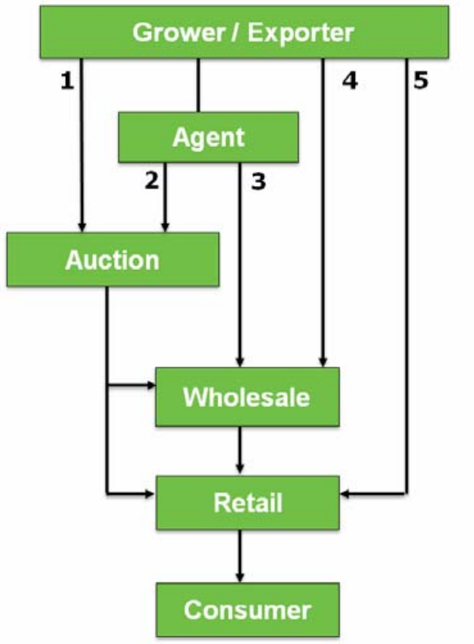


Figure 1.3: Sales channels for roses entering the EU market

Historically, auctions have been the most important channel through which Ethiopian roses are distributed to European wholesalers and retailers. But lately, the percentage of flowers exported directly to wholesalers and large retailers is increasing. The market shares differ by country but all major European markets have in common that the share of direct exports is on the increase. Still, the auctions remain the most important world market outlet for cut flowers and the most significant way that flowers reach European wholesalers and retailers.

Auctions

As we have seen, the Dutch auctions continue to play a central role in the European rose trade, both as a market place and as a distribution hub for Ethiopian roses. Auctions are co-operative wholesale markets set up by growers to market their products. There are several auction organisations in Europe. The most relevant ones with respect to Ethiopian roses are the FloraHolland auctions in the Netherlands (see figure 1.4), and the Rhein-Maas auction in Germany. The latter having been set up as a joint venture between the Landgard and FloraHolland flower auctions in 2010. The main purpose of the auctions is to handle commodities from their member growers, who are obliged to submit their whole production to the auction. The auctions in The Netherlands are nowadays open to membership for all growers in the European Union, as well as to some growers outside of the European Union. The number of members from outside Europe is increasing, noticeably in Africa. Most products submitted to the auctions are sold by means of the auction clock system. A smaller share is sold through the auctions direct trading service (FloraHolland Connect).

Roses that are traded at the auctions are generally purchased by traditional export wholesalers, who supply either other wholesalers or retailers. Besides the wholesalers, around 30% of the florists in Western Europe purchases flowers directly at the auctions. Only a few percent of florists in Central and Northern Europe purchase directly at the auctions.

Figure 1.4: Dutch flower auction Flora Holland, Aalsmeer

The auctions are constantly under pressure from other types of sales channels which bypass the auction system. Over the past years, the proportion of flowers imported into the European Union passing through the flower auctions has gradually declined, and direct sourcing by large retailers is increasing. Large retailers have increased the amount of purchases acquired directly from growers under long-term contracts. Still, the auctions remain a significant way for cut flowers to reach European wholesalers and retailers.

Agents

Many Ethiopian exporters who lack local representatives in the Netherlands are dependent on the services of agents (or brokers). Agents (also called unpackers or flower processors) deliver various services, which facilitate trade between exporters and their customers. The core activity of most agents, however, is arranging the transfer of roses from air-transport-based to auction-based packaging. Agents have adopted a range of competencies. Some agents have moved away from simple commodity handling towards providing a wider array of services including direct sales services (i.e. actively looking for buyers). Other services provided by agents are related to marketing (product introduction, market information), assistance in choosing the right assortment and even cultivation advice. These capabilities have made agents very valuable, particularly to relatively new flower exporters from Ethiopia.

Traditional wholesalers

Wholesalers are a vital link in bringing Ethiopian roses to retailers and end consumers. Most wholesalers purchase their products at auctions or from import agents. Additionally, some European wholesalers import themselves from Ethiopia. Big (export) wholesalers tend to buy from all the important flower auctions, in order to obtain the best products at the best prices. There are thousands of traditional wholesalers active in Europe. Together, they constitute a fine distribution network, mainly targeting the florist channel. While most are typically small- to medium-sized companies, others have grown into large enterprises operating in different countries. Wholesalers are confronted with high competition and rising costs and necessary investments push them towards increasing scales and further professionalization. Domestic destinations are usually florists and other retailers, whereas export wholesalers (re-)export their flowers to wholesalers and retailers abroad.

Flower providers, the supermarket specialists

Supermarkets have gained market share in the flower retail, particularly in the United Kingdom (UK). In most cases, supermarkets do not purchase flowers themselves. They purchase flowers from specialised wholesalers, also called ‘flower providers’. Flower providers are typically large scale wholesale enterprises, often with their own bouquet preparing department. There are about 20 to 30 flower providers in the European market, mostly situated in the UK, the Netherlands and Germany. Flower providers have partly taken over the function of the supermarket’s category managers. Supermarkets often need fixed quantities at fixed prices. Flower providers, therefore, cannot always rely on the day-to-day trade at the auctions. They purchase large quantities from major wholesalers and import directly, thereby generating sufficient economies of scale to bypass intermediaries.

Florists

Traditional florists still dominate the retail distribution of roses in most European countries. Even the much discussed supermarkets still have smaller shares in most countries. Other retail types like garden centres, market stalls and street sales have smaller shares.

Florists sell a wide assortment of flowers, whereas the assortment sold by other outlets like supermarkets, markets and street vendors is narrow. As a general rule, florists also offer flowers of higher quality and they use more attractive presentation than other retail outlets. In addition to providing services (such as arranging bouquets, fashioning wreaths, floral decorations and delivery), florists provide consumers information and advice about their products. They are usually more interested in novelties than other retail outlets. There will always be a need for specialised florists in Europe, particularly for flowers for weddings, funerals, corporate clients, and for offering exclusivity and creativity.

Supermarkets (and other retail chains)

The importance of supermarkets and other types of retail chains has been increasing for a number of years. However, the market share of supermarkets has stabilised in some countries. The main strength of supermarkets is the convenience they offer. As a result, supermarkets tend to concentrate on the own use and impulse consumer segment.

Some supermarket chains, the so-called discounters, rely on price competition to grasp a share of the flower market (examples are Aldi and Lidl). Other supermarkets, have made a strategic decision about their market orientation, and moved away from previous reliance on price-based factors towards strategies based on quality and service. This has resulted in supermarkets investing in supply chain relationships and pushing value-added activities down the chain towards exporters.

Being able to supply retail chains depends on the ability of the exporter to comply with their specific requirements. Besides the need for considerable quantities of uniform products, supermarkets also have very strict quality requirements, not only with respect to stem length, bud size and other visual quality characteristics, but also vase life guarantee (7 days in many supermarkets). Other typical requirements for the supermarket channel are high performance logistics (99.8% in the case of Tesco in the UK), long-term planning, and certification according to standards.

1.2.4 How prices are set

As we have seen, the role of the Dutch auctions as a price setting mechanism is still crucial in the European rose trade. Actually, most Ethiopian roses change ownership under the auction clock, where prices are set through the laws of supply and demand. Prices of roses that are traded directly (bypassing the auction system) are determined by means of negotiation between supplier and buyer. However, both parties will almost certainly relate the agreed price to what happens on the auction clock, which is often an alternative for both the supplier and buyer. In relatively few cases, price setting is based on cost price calculation. This so-called cost-price-plus method is sometimes used with long-term supply contracts and in case of a close business relationship between grower and buyer.

Prices on the auction clock

The Dutch flower auctions provide a setting where prices are determined and where growers' supply meets the buyers' demand. The auctions use the ‘Dutch auction method’ for price determination. This method uses a clock, where the clock hand starts at a high price and drops until a buyer, by pressing a button, stops the clock to bid and accept (part of) the lot for that price.

The Dutch auction clock system is highly efficient. It frees growers from the price determination process and the task of bidding and allows them to focus on production. The auction also provides a central location for buyers to meet suppliers, allowing for efficiencies in the logistics of product redistribution and quality control. Last but not least, the auction handles financial and administrative processing of transactions.

It is worthwhile to note that the prices of roses are extremely volatile. The observed price volatility is, of course, mainly due to the fact that roses are highly perishable goods. Intra-day price fluctuations can be considerable. Major causes are public holidays and climatic conditions. Furthermore, a seasonal price pattern exists. Large differences in price occur between exclusive varieties and standard flowers. New and exclusive varieties can command prices that can be way above average. Since consumers are demanding flowers that are new and different, the demand is usually higher than supply, helping support a higher price. On average, imported products sell for lower prices than Dutch products. The main reasons are the higher quality of the Dutch products, the freshness of local produce, and a range of exclusive, high-priced varieties. Note that the high quality and freshness of local flowers should also be seen in the light of quality and freshness deterioration during transport, which severely affects imported flowers.

Virtualisation and the importance of reliability

Transactions in the flower trade are increasingly handled by means of computer systems. Trade becomes virtual as the physical presence of traders and products is no longer needed at the moment of trading. Therefore, accurate exchange of information is critical.

FloraHolland plays an important role in the virtualisation of the flower trade. Their remote buying system, 'KOA', enables buyers to purchase at the auction through an internet connection. More than 60% of the flowers are currently traded via the KOA system. European wholesalers also increasingly put their products on offer in an online webshop, where customers (wholesalers and retailers) can directly buy from their stocks. In this virtual trade, buyers do not see the physical product anymore. Standardisation and correct information has to guarantee that purchasing through computer systems is reliable. Buyers need to fully rely on the information provided by the grower. Trust becomes a major issue. Ethiopian growers must therefore adapt to these standards for quality and always provide correct information about quality and sorting specifications (grading codes for length, weight, maturity/ripeness stages, and flowering stage).

1.2.5 How to get the best price

Rose prices are generally set by the impersonal forces of supply and demand. Consumer demand, often highly seasonal (e.g. Valentine's Day, Mothers' Day), influence price levels. But also weather conditions, such as excessive heat or frost periods can have a strong impact on short-term prices, as it will influence the amounts available on the market. There are however crucial factors that lie within the control of the grower. Most obviously, product quality affects price. At least as important, however, is the quality of your company's services.

Product quality

Product quality, to a large extent, is determined by several factors (see table 1.2)

Table 1.2: Product quality factors

- Variety	- Uniformity of bud size per bunch
- Size of buds	- Colour and quality of leaf
- Ripening stage at cutting	- Free from chemical deposits and water-marking
- Uniformity of bud-opening stage	- Free from pests and diseases
- Colour-brightness of flower	- Packaging
- Bud damage	- Overall appearances
- Uniformity of stem length per bunch	- Temperature of flowers on arrival

The VBN has set a number of general specifications for all product groups, which are used by the Dutch auctions. On the VBN website one may find more detailed product specifications. These requirements not only ensure clarity in commercial dealings but also quality assurance.

ⓘ VBN: www.vbn.nl/en-us/

Company reputation: reliability and trust

The importance of a growers' reputation can not be stressed upon enough. Small margins, increasing professionalisation and virtualisation in the flower trade leaves no room for surprises and errors. Wholesalers need flowers that they can buy every day to make a bit of profit with as little risk as possible. Critical factors determining a growers' reputation are:

Reliability of supply information

- More and more, growers act as their own quality inspectors. They are responsible for providing reliable (supply) information on the products they deliver to the auction and their customers. Auction suppliers are required to submit all relevant information regarding quality, grading and packaging, clearly indicated on their (electronic) delivery form. Buyers may check the reliability of the pertinent grower's supplied information through the reliability index (BI) on the clock face.

Regularity of consignments
- Consistency within and between consignments is essential. In many cases, your customer did not have the opportunity to inspect your products before buying. Most transactions are actually based on a combination of experiences of previous purchases and the information you provide.

Communication
- Constant, prompt and reliable communication is a vital prerequisite for building a long-term business relationship with your customers. If possible, smaller firms should always be reachable by e-mail and (mobile) phone at office hours.
- Keep your customers informed about how you follow up their feedback. Analyse the problem, organise improvement, implement, evaluate and report back.
- Inform customers in time about unexpected problems with upcoming orders. Do what you say and say what you do!

Branding and promotion
- To further promote the reputation of your company, you should actively build your own company brand. Be recognisable. Many growers use printed sleeves and printed boxes to make their products stand out.
- A professional and informative website and company brochure are useful instruments to inform your customers about your farms efforts to be a reliable partner.
- Participation in a trade fair such as the Horti Fair, IFTF, FHTF and IPM can be an efficient tool for communicating with customers. It provides more facilities for bringing across the message than any other trade promotional tool.
- There are many possibilities to draw extra attention to a new product. You might consider offering your flowers in separate auction batches, or spark interest in your newest launches through the auction clock. You could also display flowers in the glass display cases in the auction halls. There are options to display your products at cash & carry's, export companies and at the Intermediary Office.

The current reputation of Ethiopian flowers in the international market is mixed. Some farms are performing well but most farms need to make significant improvements if they are to become suppliers of choice for the best buyers. Several key problems are:
- Variable quality and problems with cold chains and botrytis
- Very slow or complete lack of response to issues of quality raised by un-packer and clients
- Variable supply, unreliable delivery schedules and poor communication about delivery time

> ⓘ **Remember:**
> Building your reputation costs a lot of time and effort; loosing your reputation can happen overnight!

By supplying a regular flow of respectable quality flowers, a grower will gradually built his name in the market. Buyers will start to recognise the grower as a reliable supplier and prefer his roses above products of less reliable suppliers. Some Ethiopian growers tend to supply the auction only in periods of high prices. At first glance, this would seem logical. However, it should be remembered that it is actually during the rest of the year, when prices are less spectacular, that outstanding growers built their name.

To become a supplier of choice and to have buyers looking for your flowers farms need to:
- Make sure that every shipment is the same and is of high quality
- Minimise, reject or clearly separate and label the small number of bunches of different opening stage or colour that spoil the uniformity of the shipment.
- Reject or clearly label as 'B' grade any flowers that have a problem.
- Maintain effective communications through all the links in the chain and within your own farm.
- Use printed sleeve with logo for good quality roses (A1) and no printed sleeve for 'B' quality

1.2.6 Finding relevant market information

You need sound information in order to make strategic choices. Market research is at the heart of marketing decision-making. Market research helps managers to understand new or changing markets, competition, customers and potential customers' needs and requirements.

Market information

A good starting point for finding relevant market information and links to other sources is the CBI website. After registration, which is free for Ethiopian companies, you are able to download relevant market studies on the European flower markets. CBI's market information is split into different documents, each providing market information specific to a product group or product, such as cut flowers. Subsector modules provide product group specific market intelligence on trends, segments, trade channels, prices, price developments and European Union buyer requirements. Fact sheets provide product specific market intelligence for the most promising European export markets.

ⓘ CBI: http://www.cbi.eu

Price information

As market information is increasingly becoming a competitive instrument, obtaining information on flower prices is becoming more difficult. Nevertheless, there are still a number of sources. One of the main sources of information remains the Federation of Dutch Flower Auctions (VBN) who publishes general sales statistics for all products sold at the Dutch auctions. Although a large share of trade passes through the auction, these prices should be seen only as indicative. In the case of average annual prices, no account is taken of the possible strong seasonal price fluctuations. Furthermore, varieties are often grouped together and statistics do not specify the differences in size and quality. More detailed price information can be purchased.

Another good source for price information is the International Trade Centre (ITC) in Geneva, Switzerland that collects prices at wholesale level on European markets and publishes them in their Market News Service bulletins, which are also available for subscribers.

In the end, the most important source of price information for exporters in developing countries are their own agents, importers and auctions, as these sources are able to give you pinpointed price information on variety level.

ⓘ FloraHolland: http://www.floraholland.com
ⓘ VBN: http://www.vbn.nl
ⓘ ITC's Market News Service (MNS): http://www.intracen.org

2 Structure of the rose plant

2.1 Introduction

This chapter explains about the origin of the present day commercial rose plant and gives and overview of the basic aspects of the morphology and physiology of the rose plant.

2.2 Origin of the present day cut roses

The genus *Rosa* is one of great complexity. Depending on the classification system, which is complicated due to the large amount of published names, between 100 and 250 wild species belong to this genus. The development of hybrids by crossbreeding during many centuries makes it almost impossible to distinguish the pure species from the hybrids. Only species from three different geographical regions (Far East, Europe, and eastern part of the Mediterranean) have contributed to the development of the modern rose varieties. Genetically roses are very complex as regards the number of sets of chromosomes in a cell (ploidy). Roses can be diploid, tetraploid and even penta- and hexaploid, and can have 7, 14, 28, 35 and 42 chromosomes. This and little crossing boundaries between species explains the great breeding potential.
The modern rose and most types of the genus *Rosa* form the sub-genus *Eurosa* and are part of the family of the *Rosaceae*. Most types flower in spring and summer. The most significant event in the development of the present-day cut rose took place at the end of the eighteenth century, when derivatives of *R. chinensis* and *R. gigantea* with recurrent or constant flowering, where introduced in Europe from the Far East. Possibly they were the product of many generations of breeding in China, Japan and India. Subsequent mutations and cross breeding with roses from Europe and the Middle-East resulted in the modern varieties with recurrent flowering, which is the type that is now used for greenhouse cultivation.

2.2.1 Botanic characteristics of roses

Roses are woody shrubs with composite leaves occurring spirally on the stems with the main flower. The shoots mostly have a number of labial leaves at the base. Horticultural classifications vary, but are often based on the number of flowers in the inflorescence (cluster of flowers arranged on the stem), the size of the flower, shoot length and plant shape. The most important groups are: Tea-hybrids with one or more flowers per stem, Polyantha with clusters of many small flowers; Polyantha hybrids or Floribunda and Grandiflora, with a number of flowers in between those of the two previous groups. The groups represent the different lines used in breeding.
Varieties can be distinguished by colour, shape of the flower base (thalamus), shape and position of the sepals, shape of the petals, shape of the bud, shape of the open flower, etc. (figure 2.1). The current commercial rose varieties are classified by bud size and number of buds in the inflorescence: hybrid tea roses, intermediate-flowering, sweet hearts and spray roses.

2.2.2 Ecology of roses

Wild rose species are found in the northern temperate climate zones and in the subtropical parts of the world. This includes an area from the polar circle to New Mexico, to Ethiopia, to the Himalayas, Bengal and the south of China in the Far East.
The cultivation of roses in greenhouses allows climate management in such a way that rose cultivation is possible in almost any part of the world. However, the type of greenhouse and equipment required differs per climate, and also the different varieties show different growing patterns. Varieties can clearly grow better in specific climates than in others, and this greatly affects production and quality. A good example of how climate is influencing the growth of different varieties is given in figure 2.2. The figure shows the production per plant per year of a number of varieties in different climatologically and cultural situations, being The Netherlands, Kenya, Ethiopia and Ecuador.
Some morphological aspects such as number of petals, flower shape and flower colour can be affected by location and climate. The number of petals decreases as the cultivation temperature increases. The formation of a higher number of petals at low temperature is accompanied by a decrease of the length-width ratio of the petals and replacement of the honey tray by a rapidly

multiplying tissue. These changes result in misshaped flowers called bullheads. Low temperatures may also lead to a more intense anthocyanin formation, which enhances the flower colour.

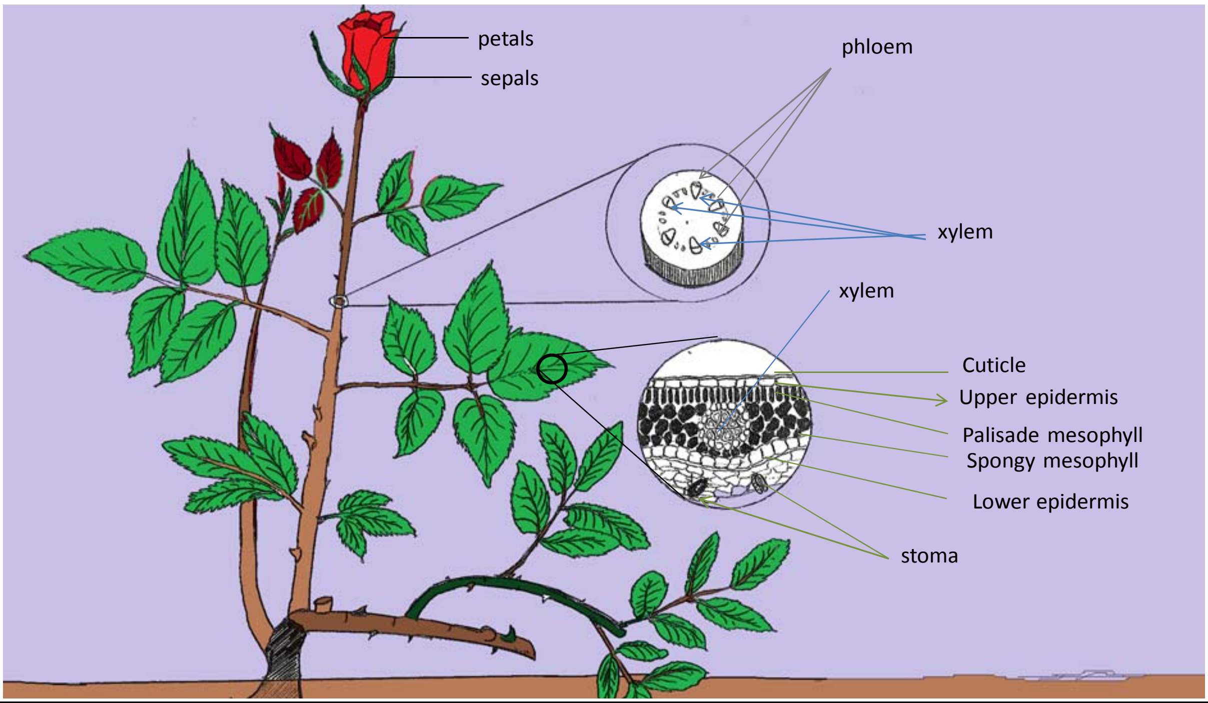


Figure 2.1: Structure of a rose plant indicating main functional tissues

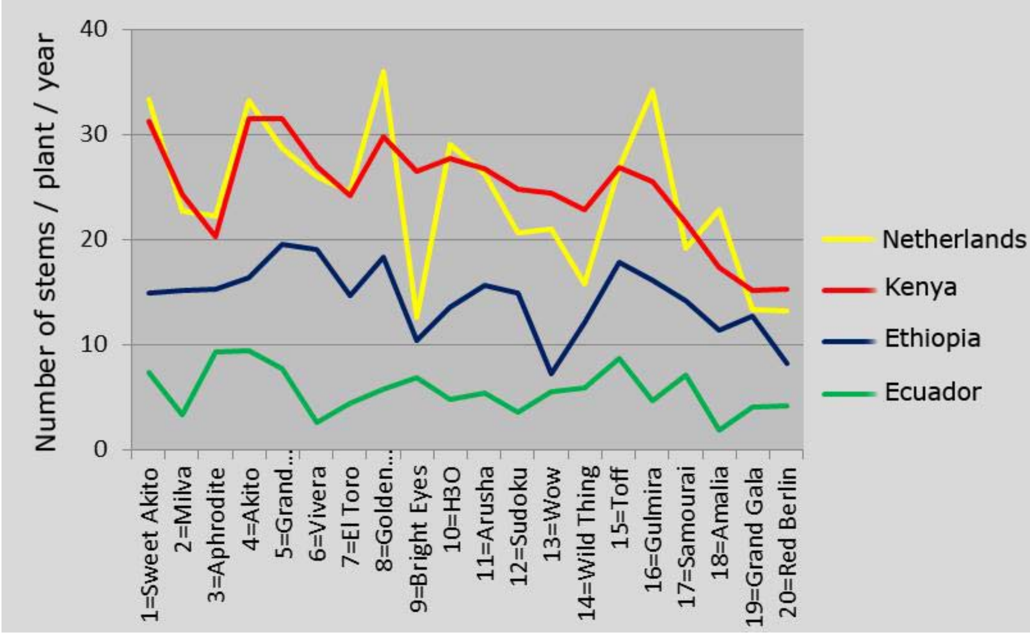


Figure 2.2: Year production in stems/plant/year) of 20 rose varieties for locations in: The Nederlands (4x); Kenya (3x); Ethiopia (1x) and Ecuador (1x). There is a clear variety-location interaction.

2.3 Physiology of a rose crop

2.3.1 The carbon balance

Any crop, including rose, needs light, carbon dioxide (CO_2), water (H_2O) and nutrients to grow and to produce flowers. In the green leafs (containing chlorophyll) of a rose plant, under the influence of light, carbon dioxide (CO_2) and water (H_2O) are assimilated into sugars ($C_6H_{12}O_6$) and oxygen (O_2). This process is called photosynthesis:

$$6CO_2 + 12H_2O + Energy \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$$

High light intensities and a high CO_2 concentration result in a high photosynthesis rate. The effect of temperature on the photosynthesis rate is relatively low. The sugars produced during the photosynthesis are broken down to CH_2O, which is the main building block of all plants. Together with some other elements such as nitrogen (N), potassium (K), phosphor (P), and many other macro- and micronutrients, it composes the dry material of which the plant consists.
However, not all CH_2O is available for growth and production of flowers, as the plant also needs energy for the support of maintenance processes, the so-called maintenance respiration. Maintenance respiration has a priority over growth and the higher the temperature, the higher the rate of maintenance respiration. The CH_2O that is not used for maintenance respiration is available to growth of the plant and is distributed over all plant organs. Young plant organs receive relatively high amounts of CH_2O, while relatively old organs receive low amounts of CH_2O. A flower stem is therefore growing much stronger than a bended shoot. Figure 2.3 visualizes the assimilation of CH_2O and the subsequent distribution to the different processes and plant parts.

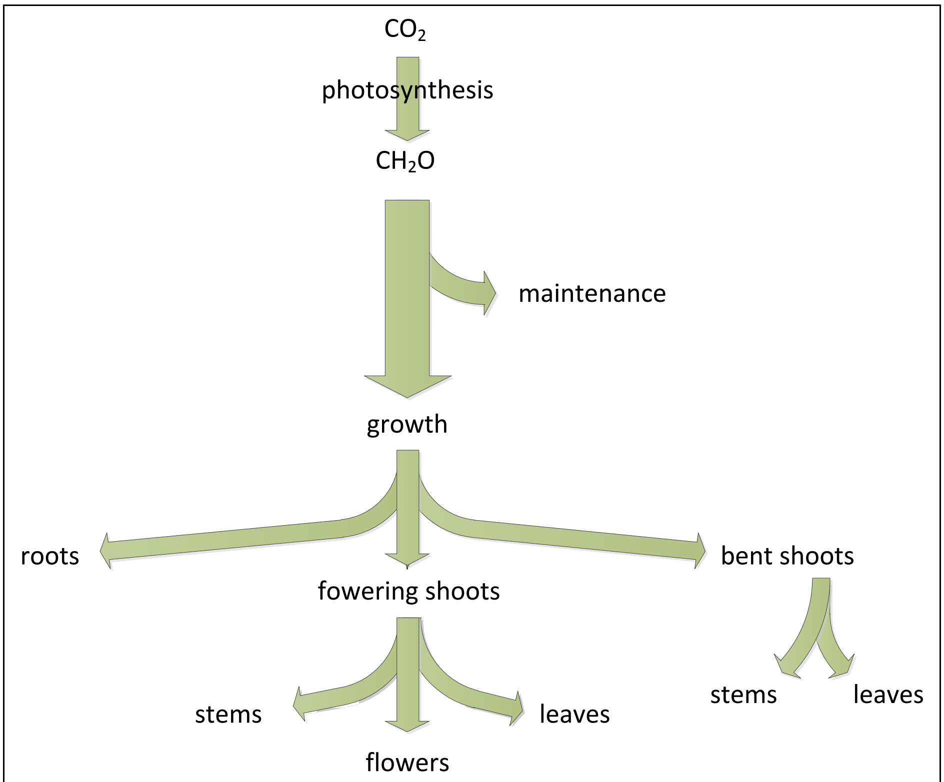


Figure 2.3: Flow of assimilates in a rose crop

2.3.2 The water balance

Some water is needed for photosynthesis itself, but by far most water is needed for transpiration. Transpiration is a process similar to evaporation and is part of the water cycle of a plant. It is the process of loss of water vapour from parts of the plant, especially in leaves but also in stems, flowers and roots. Transpiration is associated with the opening of the stomata (see figure 2.1) to allow the diffusion of carbon dioxide gas from the air for photosynthesis. Transpiration is not an active process, such as photosynthesis, but a passive process: the stomata are open, and water is lost to the air. Transpiration also cools the plant and enables the flow of mineral nutrients and water from roots to shoots. The flow of water from the roots to the leaves is caused by the decrease in hydrostatic water pressure in the upper parts of the plants due to the diffusion of water out of stomata into the atmosphere. Water is absorbed at the roots by osmosis, and any dissolved mineral nutrients travel with it through the xylem.

High radiation rates and temperatures, low relative humidity, and high air movement lead to high rates of transpiration. If the water supply is not sufficient enough to replenish the water lost due to transpiration, the stomata will close and photosynthesis will come to a stop, resulting in poor plant growth as no assimilates are produced. At night, transpiration continues at about 5-10% of the daytime rate. Figure 2.4 shows the process of transpiration and the flow of water in the greenhouse.

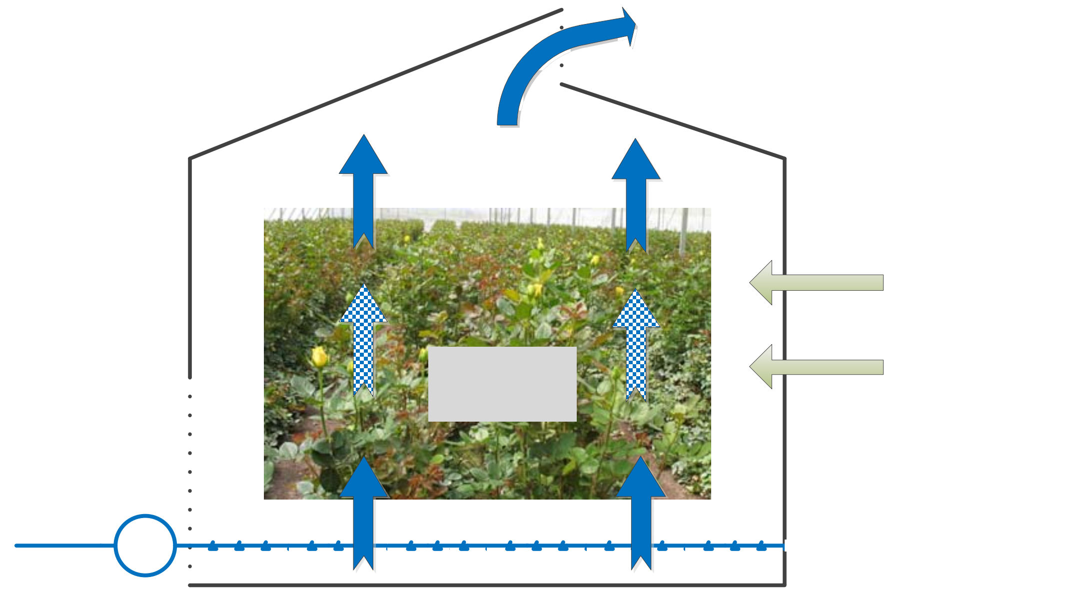


Figure 2.4: Water flow in a greenhouse with a rose crop

2.3.3 Shoot formation

In a leaf axil, a bud can be found, that can develop into a new shoot ('bud break'). This may happen if the old shoot is cut and the absence of apical dominance does no longer suppress the growth of the bud. However, not always a bud break occurs, as many factors are of influence, i.e. the rose variety, temperature, radiation, the ratio red/far red radiation, the nutritional status of the plant.

The duration from bud break to opening of the flower depends on the temperature and on the rose variety. If it is colder, as it is at higher altitudes in Ethiopia, it will take longer for the flower to be sufficiently developed and thus for the stem to be harvested. Therefore, less stems are harvested on an annual basis at higher altitudes and under colder conditions. This is illustrated for Ethiopia in figure 2.5, where data from Ziway to Holeta on production of number of stems in relation to altitude are aggregated. However, at lower temperatures photosynthesis and growth are less influenced and the stem itself will continue to grow, and thus at lower temperatures with longer time for flower development, stem length will still increase. As a consequence, under colder conditions the number of harvestable stem per m^2 will be less, but will be higher in stem weight.

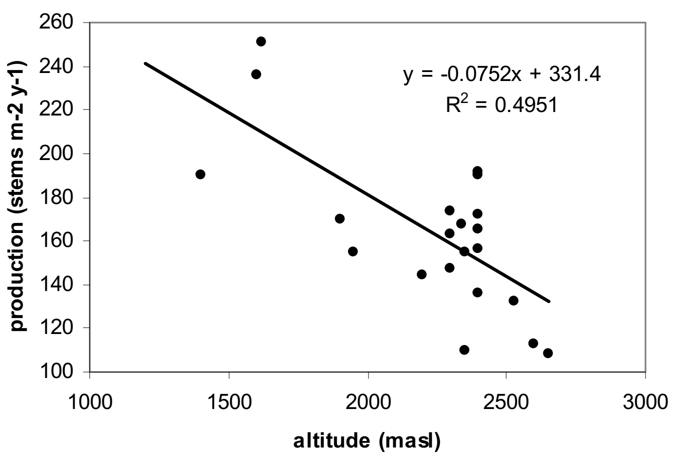


Figure 2.5: The empirical relation between altitude of rose farms in Ethiopia and their annual production of rose stems (Source: den Belder & Elings, WUR, 2007)

2.3.4 Hormonal growth regulation

Plant hormones are natural growth regulators that control developmental processes in the plant, in for example rooting, length growth, branching and senescence. Hormone production takes places in several organs and tissues. Discussions are going on whether to call these substances hormones or growth regulators. In plant breeding the name growth regulator is increasingly used in detriment of the name hormone. To date, 5 groups of plant regulators are known: auxins, cytokinins, gibberellins, abscisic acid and ethylene.

Auxins

Auxins affect growth by cell elongation, cell division and cell differentiation. Auxin promotes the formation of adventitious roots. Auxins are being applied for the rooting of roses in propagation.
Auxin is the earliest known hormone, with indole-3-acetic acid or IAA as most important natural representative. Auxins are especially formed in the growth tips of stems, in leaves, in flowers and in seeds of growing fruits. In these organs they promote the cell elongation and the related metabolism, probably also the compound uptake from the nutrient phloem. Auxin is transported in the plant from top to bottom from cell to cell via the parenchym and from the leaves also via the phloem. Thus it moves to the roots, where apparently it can quickly be inactivated, because otherwise the root growth, which is sensitive to auxin, might be inhibited.

Cytokinins

Cytokinins play a role in the formation of bottom breaks and reducing the aging process of especially leaves. In interaction with auxins, cytokinins control growth, branching and senescence of the shoot.
The production (biosynthesis) of cytokinins mainly takes place in the root tips. In the transpiration flow they are transported to the aerial parts, and, after transition in the vascular bundle to the phloem, to the developing organs, particularly when these organs produce auxins. The formation of cytokinin depends on the root activity. Factors impeding root growth such as water deficit, shortage of certain nutrients or oxygen deficiency reduce the cytokinin content and consequently inhibit the development of aerial plant parts.

Gibberellin

Gibberellins induce cell division in the subapical meristems (all growth points below the apical growth point), stimulate stem growth and play a role in dormancy bud breaking. The biosynthesis of gibberellin (GA) may take place in virtually all plant parts. Gibberellins circulate through the entire plant through the xylem and the phloem vessels and promote the growth of the shoot. The gibberellin synthesis can be inhibited artificially by application of synthetic regulators, which are applied as growth retardants to inhibit length growth. In a rose crop this is not necessary.

Abscisic acid

While cytokinins and gibberellins have dormancy breaking effects, abscisic acid has a dormancy inducing and growth inhibiting effect. Abscisic acid (ABA) is formed mainly in the chloroplasts of the chlorophyll cells. They accumulate in the membranes and may be released quickly under stress conditions, possibly as a result of the decline of the cytokinin supply from the roots under these circumstances. Abscisic acid is also issued by the leaves, both via phloem and xylem vessels, especially to the growing parts. In full-grown tissue Abscisic acid stimulates senescence. Under unfavourable conditions the synthesis of auxin, cytokinin and gibberellin usually decreases, but that of abscisc acid continues or even increases.

Ethylene

Ethylene is very similar in effect to abscisic acid. Generally it inhibits growth of the young cells and promotes senescence of mature tissues. Cytokinin counteracts the inhibition of cell division caused by Ethylene. The cell elongation that is promoted by auxin is inhibited by ethylene. Under unfavourable and stressful situations the synthesis of ethylene is stimulated. Furthermore, the synthesis of ethylene is autocatalytic, which implies that it promotes its own synthesis. As senescence hormone ethylene is active in flower wilting and affects post-harvest quality.

The formation of ethylene may take place in all plant parts, particularly under stress conditions, such as drought, heat, cold, or mechanical damage. Ethylene may be released as a result of inadequate combustion of fuel and cause serious crop damage.

3 Management and organisation

3.1 Introduction

Management and organisation of a farm can be described as the process of planning, organising, leading and controlling farm employees and associated processes, with the objective of maximizing profits from the farm business on a continuing basis. In this regard, good management and proper organisation of the farm has to a large extent an effect on reaching the goals that have been set and the efficiency by which they can be achieved.

3.2 Farm organisation and management

An organisational structure consists of activities such as task allocation, coordination and supervision, which are directed towards the achievement of organisational aims. A farm can be structured in many different ways, depending on size and objectives. The structure of the farm will to a large extent determine the modes in which it operates and performs. The organisational structure allows the allocation of responsibilities, tasks and processes to different entities such as units, departments, teams and individuals. In figure 3.1 and example of a possible farm organisations is visualized in an organisation chart.

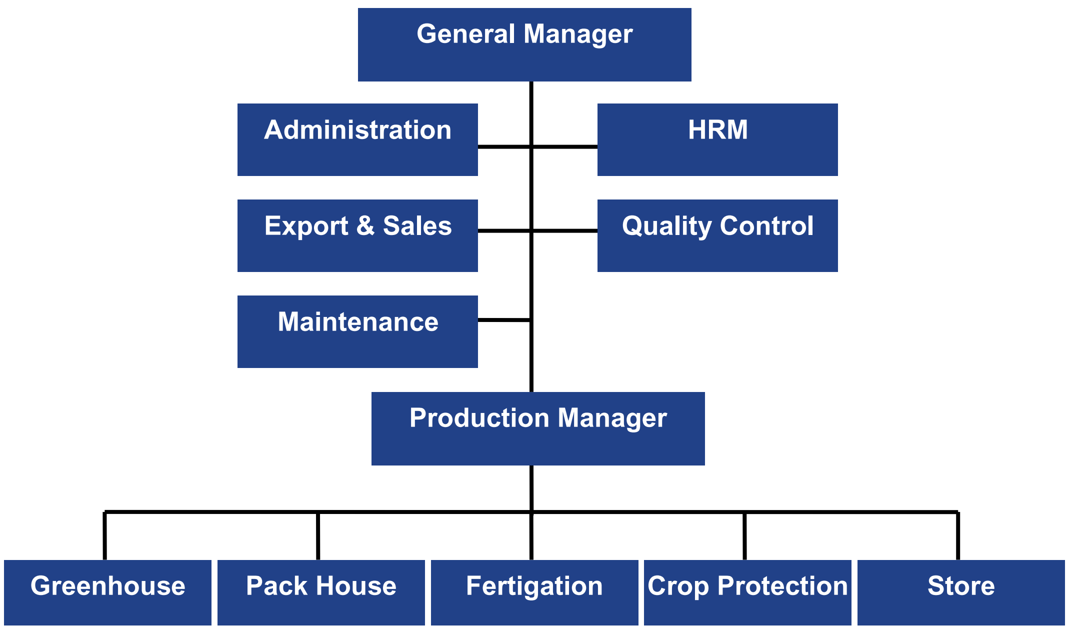


Figure 3.1: Example organisation chart of a rose farm

Organisational structure affects organisational action in two ways. First, it provides the foundation on which standard operating procedures and routines rest. Second, it determines which individuals get to participate in which decision-making processes, and thus to what extent their views shape the organisation's actions. Most Ethiopian rose farms are characterised by a clear and simple chain of command, which identifies a number of decision levels in the farm organisation, i.e.:

- Farm management (e.g. owner, general manager, farm manager, production manager)
- Middle management (e.g. department heads, (senior) supervisors, team leaders)
- General employees (e.g. the peope concerned with the execution of the actual activities)

Responsibilities and tasks of each position are laid down in job descriptions. The highest decision-making unit in the company is the owner and/or shareholders. Shareholders' approval is required for major decisions like investments in new greenhouse structures or long-term strategies. Most operational decisions are taken by the general manager and production manager.

Typically, farms identify a number of departments (see figure 3.1). These departments are led by a department head or (senior) supervisor. Departments are further structured into units or teams and are led by a supervisor or team leader. Most medium and large-sized Ethiopian rose farms are organised according to a simple management and organizational structure.

3.2.1 Management process

The management process concerns all levels of business activity (strategic, tactical and operational level) and should lead to an efficient and effective production process by planning and deciding your strategies, tactics and operations. Analysing the farm's flower production process will provide new information to improve your internal and external management processes. The process should be a reciprocal procedure (see figure 3.2).

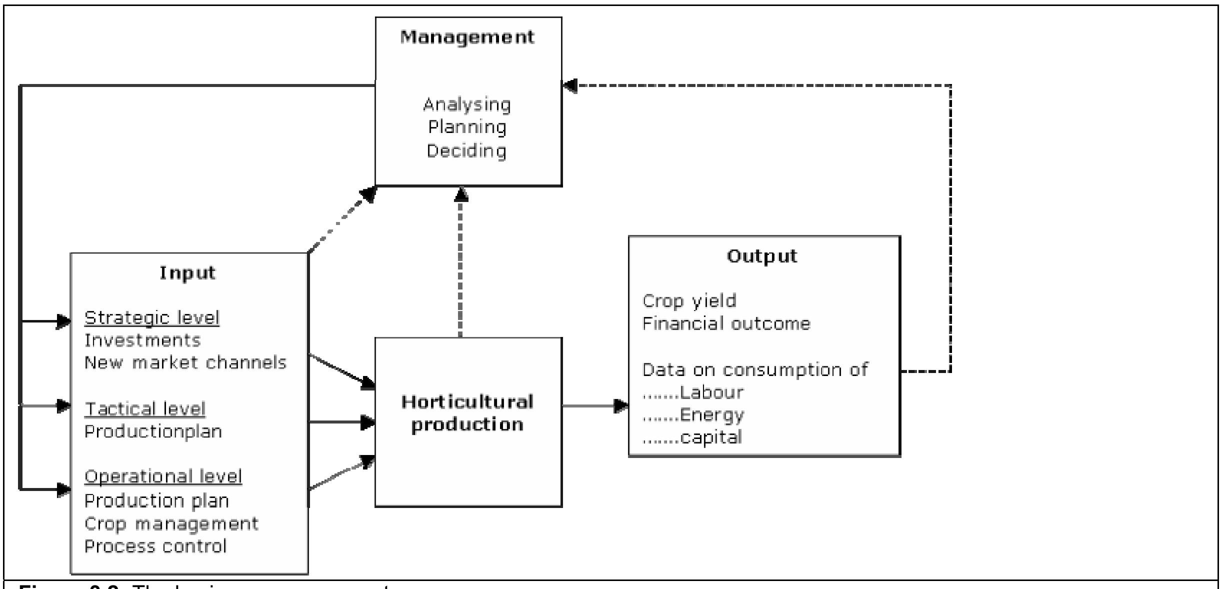


Figure 3.2: The business management process

A good balance between strategic and operational management are essential for keeping your company healthy and efficient. Good business management needs both types of management with clear interaction and balanced attention. Strategic management questions should be translated into operational ones and must be considered on a daily basis.

Strategic management questions deal with long-term visions. It enables you to set realistic objectives and to perform analysis to develop the right business strategy. Most of the time, these are 'what' and 'how' questions. What are my target markets and sales channels? How do we distinguish ourselves from competition?

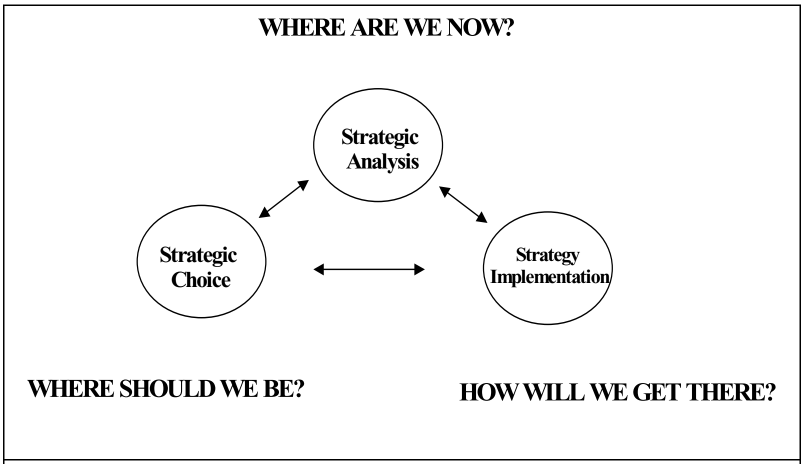


Figure 3.3: The three basic strategic management questions

Operational management is of need to operate efficiently and effectively. Operational management develops rather tactics than strategies and starts with implementing the chosen strategy and regulating the day-to-day procedures. Some examples of operational management questions are: What went well in the stocking process? What went badly in the sales process and why? What were the costs and where could savings be made? What processes could be simplified and how?

3.2.2 Human Resource Management

The human factor is crucial in the successful development of an enterprise. Human Resource Development is the exchange between management and employees to create conditions where people can learn and develop their potential qualities. This will benefit the enterprise and the employees. Concerning the growth of roses we have a lot of expertise on how we can create optimal growing conditions to enable the crop to produce on an optimum level. Besides this, it should also be considered how to optimize the conditions needed to enable employees to 'produce' at an optimum level.
The challenge for (senior) management is to create a commitment from people, that results in high output. Important topics for human resource management are leadership, motivation, communication skills, team building, recruitment and selection, training, internal communication, creative and innovative thinking, conflict prevention, study group learning, etc. (see figure 3.4).

Leadership

Leadership has been defined as the process of accomplishing desired results with and through the efforts of others. So emphasis of effective leadership is the achievement of good results. In order to achieve good results, leaders need to influence their staff. Therefore successful leadership is closely related to the ability the leader uses to influence his staff towards achievement.
To be a successful leader, one needs to acquire and use appropriate influential skills, skills that can assist people to accept and be ready to act toward the achievement of the results. But the leader can only attain such results if he is working closely enough with others and assisting them to work toward the achievement of results.

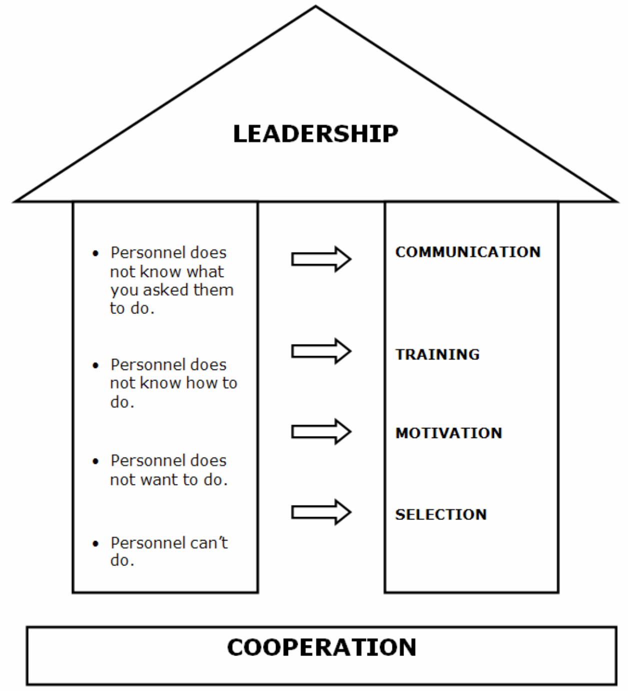


Figure 3.4: Six elements of HRM

Motivation

Motivation is about how people act or behave the way they do. For example, at work some people work harder and are more effective (obtain better results) than others. This is about the commitment from people. Motivation is a process of satisfying the wants and needs of your employees by encouraging and helping them to perform their assigned jobs more enthusiastically. The factors that motivate people can change over their lifetime, but "respect me as a person" is one of the top motivating factors at any stage of life.

Effective communication

Communication on a farm may be verbal and non-verbal. Most of the time we only pay attention to the verbal aspects of our message when we communicate and hardly consider the (often non-verbal) relational and procedural aspects of it, even though these two aspects of communication are closely connected and interact with each other. In this regard, keep in mind the following guidelines for effective communication:

1 *Actual content (WHAT?)*
  This is information about a subject (mostly verbal). The quality of the message depends on:
  - Clarity: what does he say exactly?
  - Effectiveness: what does he mean exactly?
  - Expertise: is it correct what he says?

2 *Relational aspect (WHO?)*
This is the way in which sender and receiver are related to the message and to each other (mostly non-verbal). The quality of the relational value of the message depends on:
- Appreciation and acceptance of the other person
- Attention, involvement and state of mind
- Understanding the other person
- Sincerity and honesty
- Self-image and perception of the other person
- In-between distance and interdependence

3 *Procedural aspect (HOW?)*
This is about the way the message is sent (logical structure, time, place) and means, such as telephone, e-mail, fax, letter or personal contact. With transmitting a message, keep in mind that for different communication channels the level of personal contact and/or the possibilities to use non-verbal communication differs. So make sure in the way you communicate, that the message is received and understood as intended, so no miscommunication takes place.

Training
Training is important. Well-trained farm employees have a good understanding of their job and know how to do their tasks correctly, safely and efficiently. Development of human resources on a farm, therefore, requires continuous attention for training skills, knowledge and attitude. For management it is important to be aware of two vital aspects:
- Trainees are adults with life and work experience. Use this in the training.
- Participation and interaction are vital; actively involve the trainees in the process.

To illustrate this, early learning theory was based on knowledge gained first from studying animals then children. In early adult education adults were taught as children. Because of this much adult education was unsuccessful. We have since come to realise that adults learn in a very different way. Four major differences are:
- *Experience:* Adults have a vast reservoir of experience that is a valuable resource for learning. If these experiences are devalued or ignored then barriers to learning are often created
- *Self-concept:* Adults are independent, self-directing beings who like to exercise control over their learning
- *Immediacy of application:* Adults are motivated if their learning can be applied immediately, not in the distant future
- *Social rotes:* Adults are motivated if their learning is of benefit to them in one of their current roles in life

In this view, Implications for trainers are:
- Participatory methods should be used
- Adults need a supportive listening environment
- Adults need to be able to diagnose their own needs and to plan their own learning; they may, however, need help with this
- Adults learners need to be given as much information about the programme, methods and purpose of all aspects of a course in which they are participating; In this way they can take responsibility for their own learning
- Shared responsibility of trainer and trainees should be an important feature of any adult learning programme
- Adults need to be able to explore new material and concepts in the light of their own experiences

Selection
An entrepreneur selects the right person for the right job. In the selection of staff for supervisory and management jobs the sheet on performance appraisal can be a helpful tool in this selection process:
1. The manager makes an appointment with the staff member, at least one week before the implementation
2. The manager explains the items and the procedure of this Performance Appraisal sheet

3. Both manager and staff member fill out a Performance Appraisal sheet and bring it to the appointment
4. During the appointment the manager and staff member compare and clarify the outcome of the filled out PA sheets
5. At the end of the performance appraisal a short summary is made by the manager

Cooperation

In building a team it is essential that group members make each other stronger and supplement each other in content, procedure and interaction, and are aware of their shared objectives. In this sense the sum of the parts is greater than the whole. Eventually this to lead to better quality and productivity of your employees

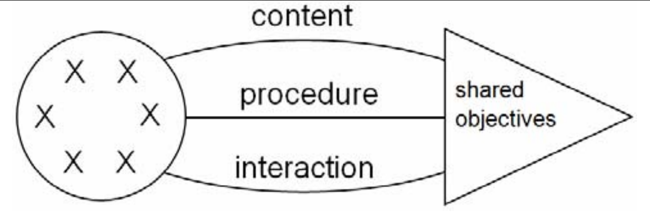


Figure 3.5: Four key aspects of cooperation

3.2.3 Role of the management team

The role and position of the management team in a process of change is very important. Trust in the management promotes the fast transition from the old to the new situation. This results in the situation that staff members in the company note, more than usual, how the management team functions. Points of attention are:

To clarify vision and goals
- Are these goals SMART?
- Are we consistent in our policy?
- Is there a balance in the goals?
- Have we reached commitment?

To pay attention to internal communication
- Who is responsible for the communication concerning a certain issue?
- Do we link the information to what staff knows already?
- Do we communicate, when there is stagnation?
- Is there two-way communication?

To know what is going on in the company
- Do we know most important signals?
- Do we interpret the signals in the same way?
- Is there trust in the MT?

To mention progress and milestones
- When is the change process finished?
- Do we all know the next mile-stone?
- How long are we away from the next dead-line?
- How do we communicate that we have or have not reached a mile-stone?

Practice what you preach
- How do we cooperate in the MT?
- Do we behave as an open management (room for influencing)?
- Do we take time for long term development?
- Do we have structured meetings?
- Do we support each other?

ⓘ **SMART:**

Specific: The goal is clear and unambiguous

Measurable: Concrete criteria for measuring the progress towards achieving the goal

Acceptable: The goal is sufficiently acceptable for the target group and / or management

Realistic: The goal is realistic and attainable, within the availability of resources, knowledge and time

Timely: There is enough time to

3.2.4 Eight skills of leadership

In order to achieve good results, leaders need to the following skills:

1. *Focus on results:* Always make sure that your team and each member of the team has a clear picture of what they are expected to achieve and how well they should do it. In some cases, you may establish targets yourself; in other cases you may do it through consultation with team members.
2. *Lead by example:* Set the example for the quality of work and effort you expect from your team. Walk your talk, practice what you preach.
3. *Communicate*: Give your team all the information they need to do their jobs well. Communication is a two-way process. Always listen to your staff and encourage them to contribute ideas.
4. *Delegate:* Pass on as much responsibility as staff can take. Leading by example does not mean that you do everything yourself - your aim is to get results through your staff.
5. *Give attention:* Show that you recognise the value of each person's contribution to the team and to business success. This means respecting people as individuals, paying attention to individual needs and problems and letting staff know that their contributions are appreciated.
6. *Build team spirit:* Aim to develop a sense of team identity at all times, so that each individual works well with his colleagues. While there are a number of individual jobs, a great part of the work depends on co-operative effort.
7. *Be fair and consistent:* Set clear standards and stick to them, for work and discipline at work. If these standards are the same for everyone, you will gain a reputation for fair dealing.
8. *Act decisively under pressure:* Make firm, reasoned decisions under pressure, staying true to the principles of leadership described on these pages.

3.3 Choosing a rose variety

One of the important roles of management and what is at the basis of the farm's strategy is selection the right rose varieties to cultivate on the farm. Whether you are in Africa or elsewhere in the world, whether you are new to the business or have many years of experience, picking the right rose varieties for your greenhouse production is always a strenuous, time consuming endeavour, with potentially considerable impact on your company's profit and sustainability. In Ethiopia, typically the farm manager (director) is responsible for the decision which varieties to plant.

3.3.1 Choosing the right varieties

The company strategy that is written down in the business or export plan should always be leading in developing a fitting assortment plan (see figure 3.6). Which set of varieties will help us, for instance, to capture the UK supermarket channel? Which varieties are most interesting when selling through the auction or targeting the Russian market?

Overall, the selection of a variety is determined by balancing production criteria with market factors. On one side, the growth potential for each shortlisted variety for you specific location needs to be identified (bud size according to market demands), and you will need to estimate the cost price per stem. What is its productivity on my location? What are the costs to produce and transport the product to the market? On the other side, you need to know if there will be sufficient demand for this variety, particularly in your target

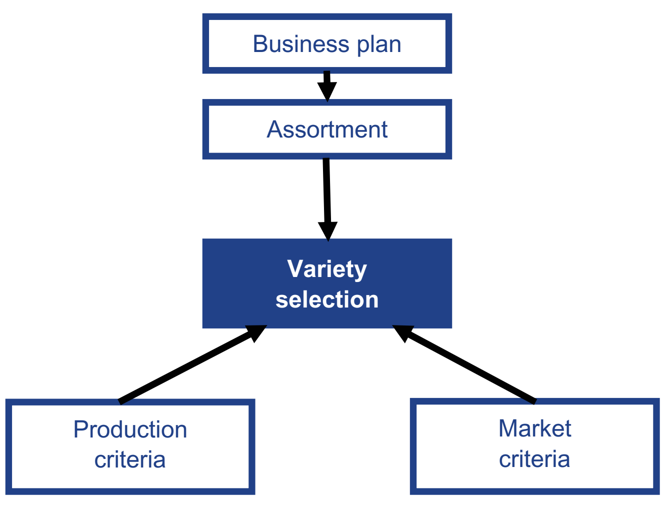


Figure 3.6: Variety selection

markets and sales channel.Based on the company and subsequent assortment strategy, the selection process is the outcome of an ongoing process in which different departments are consulted. Additionally, you will have to seek advice from external parties, e.g. agents, breeders, auction representatives and traders. Your colleague growers can also be a useful source of information as they might have personal experience in cultivating and marketing a specific variety. Some important production and market criteria for selecting a rose variety are given in table 3.1. In table 3.2 the main varieties grown in Ethiopia in 2010 are given.
However, also keep in mind that unbiased information about a variety's production characteristics and market prospects is hard to find. Base your decision on information from trusted parties and double check if possible. Is this person really knowledgeable? Why is he giving me this information?
With respect to the availability of varieties, it should be noted that starting growers tend to encounter more difficulties obtaining interesting varieties. Breeders often keep the best varieties for their preferred growers. It takes time to develop a relationship with breeders, but it is an important aspect of the flower business.

Table 3.1: Important criteria for selecting a variety

Production criteria	Market criteria
- Climatic requirements	- Does the variety fit in my assortment strategy?
- Productivity per square meter	- How many growers are supplying?
- Disease resistance	- Will demand increase or decrease?
- Trials in your country	- Which markets and sales channels buy this variety?
- Amount of rejects	- Good vase life?
- Packin rate	- Transportability?
- Damage sensitiveness (transport)	- Current quality at the market?
	- Competitiveness with other varieties?

Table 3.2: Top 10 rose varieties in Ethiopia in 2010

Rank	Variety	Rank	Variety
1	Viva!	6	Blizzard
2	Duett	7	Red Calypso
3	Marie-Claire!	8	Mariyo!
4	Belle Rose	9	High Society
5	Red Sky	10	High & Magic

3.3.2 Intellectual property

The development of new plant varieties (breeding) is usually a costly affair. Intellectual property rights allow companies engaged in the plant reproduction material sector to obtain the exclusive right to their product. During a certain period of time, companies can levy fees. This income is used to earn back the investment in the product made by the companies and can be used to invest in the development of new varieties. The most important aspects to consider relating to the development and exploitation of plant varieties are mainly Plant Breeders' Rights, Patent Rights and Trademark Rights.
Plant Breeder's Rights ensure the owner of a new variety certain control over the commercial use of that product. In that manner, it also promotes the availability of the new variety to the trade as the owner has the possibility to ask a contribution for his efforts.
The extension of breeders' rights to flower varieties is currently advancing in many countries. The agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) within the World Trade Organisation (WTO) has provided the motivation for many developing countries to adopt some form of plant variety protection regime.
Ethiopia, however, has not yet joined the WTO. Therefore, the TRIPS Agreement is not applicable to Ethiopia at the moment. However, the country has applied to join WTO and there are some ongoing tasks to make the country's intellectual property laws TRIPs compliant. The government, therefore, has a positive attitude towards the TRIPs Agreement. In 2003, the Ethiopian Intellectual Property Office (EIPO) was established to oversee the protection of patents, trademarks and copyrights under

one umbrella. Ethiopia's Plant Breeders' Rights Proclamation of 2006, however, has not been implemented yet.

Delicate situations

The methods for enforcement of breeders' rights are improving. Regulations for customs control have become increasingly sophisticated and effective. As a result, a variety protected in the EU cannot freely be exported to any EU member state. As soon as the product enters the EU, the breeder can exercise his rights. There have been examples of seizure of illegal Ethiopian roses when entering Belgium.

Compliance with breeders' rights is also critical when auctioning roses. FloraHolland, for instance, has made agreements with the Dutch breeders' association (Plantum NL) about the procedure regarding the supply of flowers for which no royalties have been paid. This protocol describes the procedure with which breeders' rights holders can submit a request for action to the auction and how and in what situations FloraHolland may become involved. If infringements are ascertained, sanctions can encompass destruction of the flowers, including the imposing of a fine and/or ending membership at FloraHolland.

3.3.3 Marketable lifetime of a rose variety: Product Life Cycle

The marketable lifetime of a rose variety can be characterised by the concept of Product Life Cycle, which consists of the phases: introduction, growth, maturity, saturation and decline (see table 3.3). PLC analysis can be a useful tool, particularly when choosing among established rose varieties.

Table 3.3: Product Life Cycle

Stages	Characteristics
1. Market introduction stage	1. low production volumes 2. little or no competition from other growers 3. introduction costs: promotion of variety 4. demand has to be created 5. customers have to be prompted to try the product 6. makes little money at this stage
2. Growth stage	1. costs reduced due to increasing economies of scale 2. production volume increases significantly 3. profitability begins to rise 4. awareness among customers increases 5. competition begins to increase with a few new growers 6. increased competition leads to pressure on prices
3. Mature stage	1. costs are lowered as a result of production volumes increasing and experience curve effects 2. sales volume peaks and market saturation is reached 3. increase in competitors entering the market 4. prices tend to drop due to the increased supply 5. profits go down
4. Saturation and decline stage	1. costs become counter-optimal 2. sales volume decline or stabilise 3. prices, profitability diminish 4. profit becomes more a challenge of production/distribution efficiency than increased sales

Calculating marginal sales to determine PLC phase of a variety

The path from one phase to the following phase is defined by the changing values and/or signs of the marginal sales. Marginal sales are the changes in the sales from one year to the following one:

- Positive marginal sales means that sales are increasing.
- Negative marginal sales means that sales are decreasing.

The first phase is the 'Introduction', which occurred in our example in 1981 and 1982 (see figure 3.7). The second phase, 'Growth', lasted three years (1983 to 1985) and can be recognised by increasing marginal sales. The third phase, 'Maturity', lasted for four more years (1986 to 1989). During this phase, marginal sales decline. The fourth phase, 'Saturation', lasted from 1990 to 1992, when marginal sales were fluctuating. Finally, the variety entered the fifth phase, 'Decline', from 1992 to 2000, passing through a period of negative marginal sales.

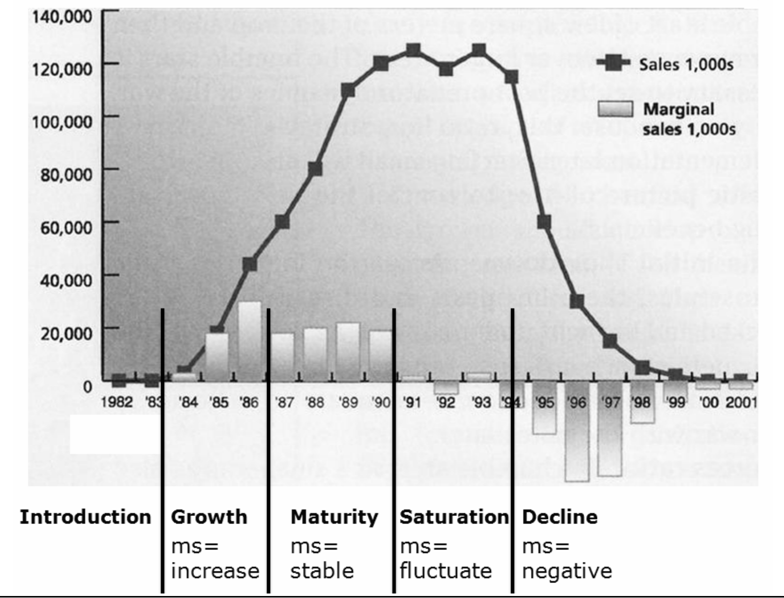


Figure 3.7: Product Life Cycle of rose variety Madelon

4 Record keeping and data use

4.1 Introduction

Good farm management decisions are based on accurate, reliable and timely information, through which losses can be minimised and profits can be maximised. It is a matter of collecting, processing and subsequently analysing and interpreting the farm data. Basically records should be kept of anything that will be used to make decisions. When certain data is not used, then do not spent time and money on recording it. Once the data is available, it is interpreted and decisions are made on actions to take to maximise the efficiency of the farm. Recording farm data does not need to be a complex process. The aim should be to establish a system, which becomes routine and complements the daily farm tasks.
At the moment, in general the availability of accurate and reliable recorded data is one of the things that is lacking on Ethiopian farms. Partly this can be attributed to infrastructural problems. Because of lacking information, the farms are not managed to their potential. However, improvements are made by the introduction of high-tech measuring devices and training of farm management in record keeping and making use of information and data collected to improve farm results.

4.2 Theoretic background

4.2.1 PDCA Cycle of Deming

A good way to illustrate how record keeping and collected data can be used for decision making on the farm, is by making use of the PDCA Cycle of Deming (figure. 4.1). The Deming cycle consists of four successive steps:

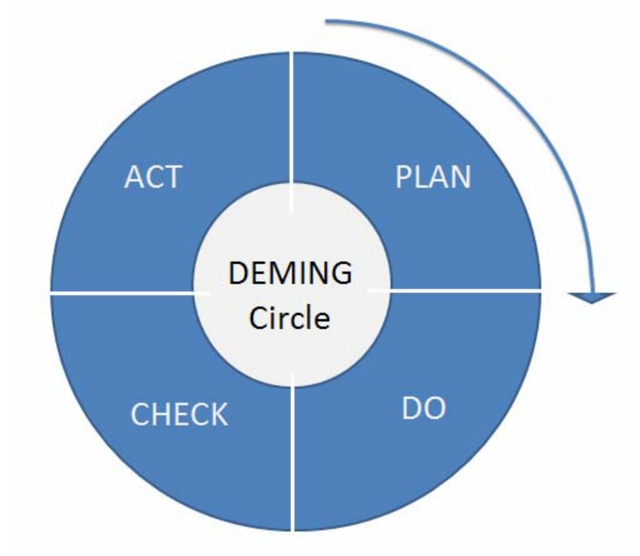


Figure 4.1: PDCA Cycle of Deming

1. Plan
Define the objectives and processes required to achieve the desired or expected output

2. Do
Implement the newly defined objective and processes (initially on a small scale to test possible effects) and collect data for analysis

3. Check
Use the collected data to compare and analyze the actual results against the desired or expected output

4. Act
If the results deviate from the desired or expected output, determine where to make adjustments for improvement, redefine the objectives and processes, and go through the cycle again

In practice, for a rose farm the overall objective will be to reach a certain level of production quantity and quality in order to be profitable. Using the PDCA Cycle of Deming can give you more insight in how to reach this objective:

1. *Plan:* Determine for you farm what level of production (stems m^{-2}) and quality (stem length) should be obtained (for each variety grown on the farm) in order to be profitable. Cost price estimation (see chapter 11) can give you more insight in what should be your objective for production and quality. Subsequently define the requirements and processes (e.g. bush management, fertilization & irrigation, crop protection, climate management) and specifications for implementation for how you think you can achieve the goals of production quantity and quality.

2. *Do:* Implement the set of measures, that you have composed based on your desired goals, and keep records of all processes during the production process (e.g. climate, fertilization, irrigation, crop protection, stock, production output).
3. *Check:* After a first production round, use the collected output data to check if the quantity and quality outputs reach the objectives you have set.
4. *Act:* If the objectives have not been achieved, use the collected data of the production process to find out where in the production process mistakes were made (e.g. wrong bush management, wrong climate, wrong crop protection measures), or where processes can be made more efficient (e.g. grow different stem lengths, more efficient stock management) and thus where adjustments for improvement need to be made. Subsequently redefine your goals, requirements, processes and specifications, and go through the PDCA Cycle of Deming again.

Full insight in all the processes of the production chain is required to enable to make adjustments where needed and to reach the desired objective. To make the right decisions for adjustments proper record keeping and relevant information are essential. Figure 4.2 shows how and where in the production chain information is important. Besides record keeping and decision making for the different processes of the production chain, also a differentiation in record keeping on the long (strategic), medium long (tactical) and short term (operational) can be made, which is shown in figure 4.3.

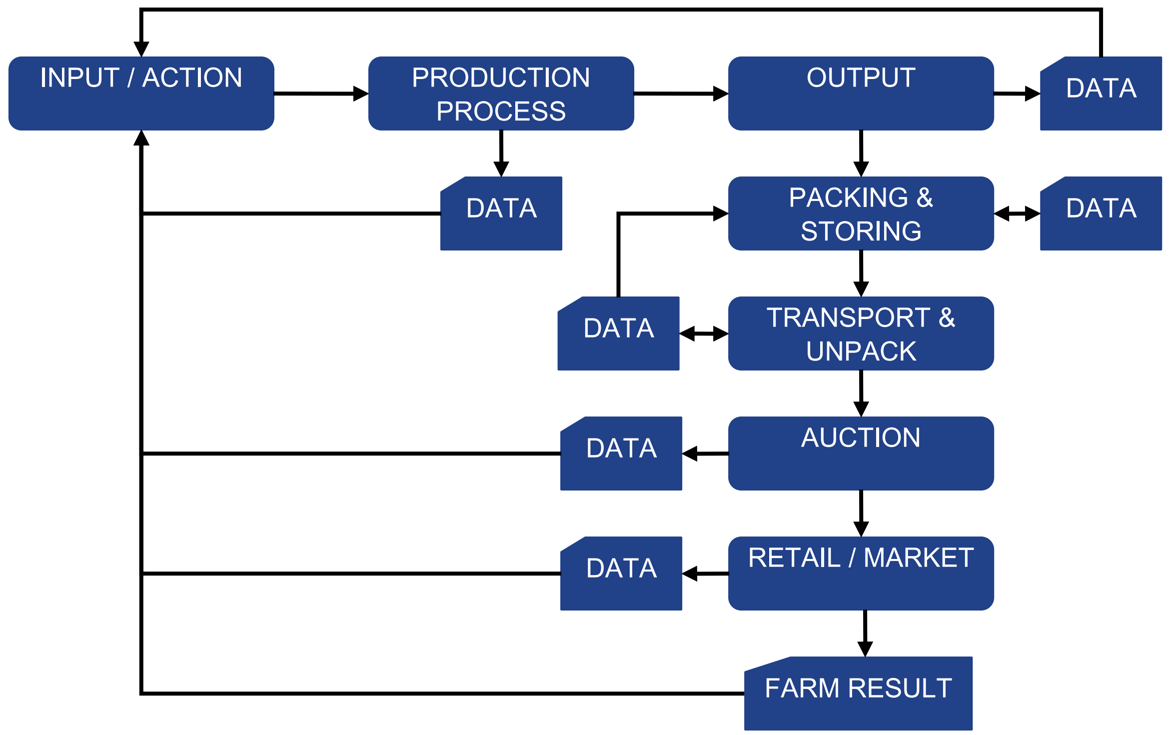


Figure 4.2: The use of data within the production chain

Record keeping of inputs, actions and the production process includes data on climate (inside and outside the greenhouse), fertilization, irrigation, crop protection and stock keeping. The analysis and interpretation of the data is directly used for operational decision making to optimize the production process. The result of the production process and recorded data on production quantity and quality are compared to the desired production, based on which tactical decisions can be made to adjust the inputs or the production process itself to reach the production level.
Record keeping during packing & storing and during transport & unpack assure that the quality of the product is maintained during transport and reaches the auction or client in good order. Interpretation of the data and communicating the feedback is important for operational decision making to maintain product quality during transport.

Retail, market and auction information include data on market prices, demands and requirements and are very important to take into account for tactical and strategic decisions, as the market for roses is very dynamic (see chapter 10).

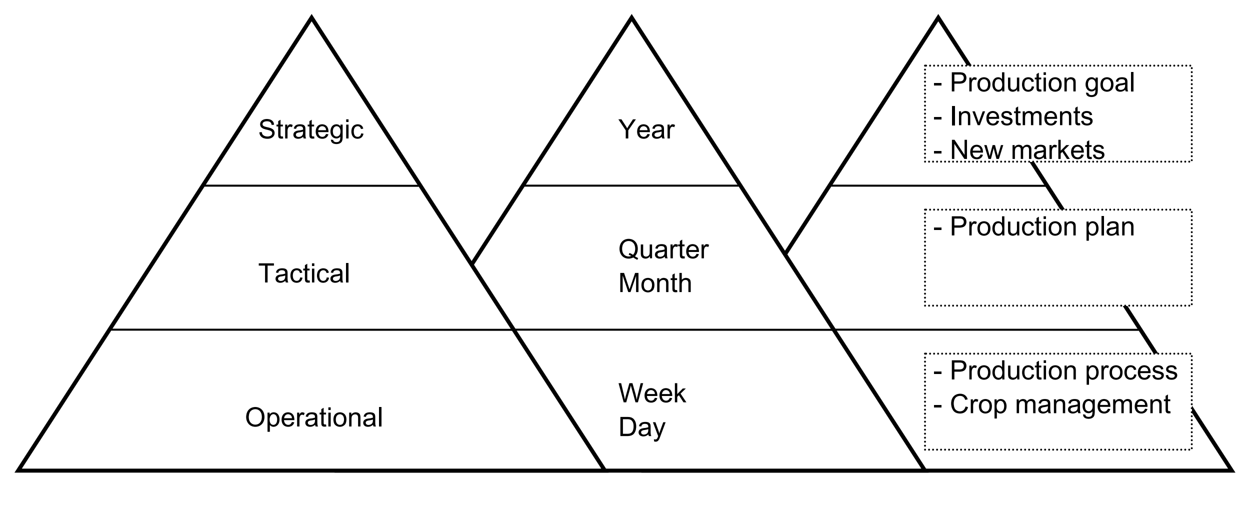


Figure 4.3: Levels of planning & decision making

4.2.2 Communication of data

Communication of data is just as important as the actual data collection. After collecting the data, make sure it reaches the right persons that can process, analyse and interpret the data. The outcomes need to be discussed with the responsible and authorized persons, and decisions need to be made for adjustments or improvements. Subsequently, the people who perform the actual operations in the greenhouse should be instructed on how to implement the adjustments. In figure 4.4 the process of data communication is visualized.

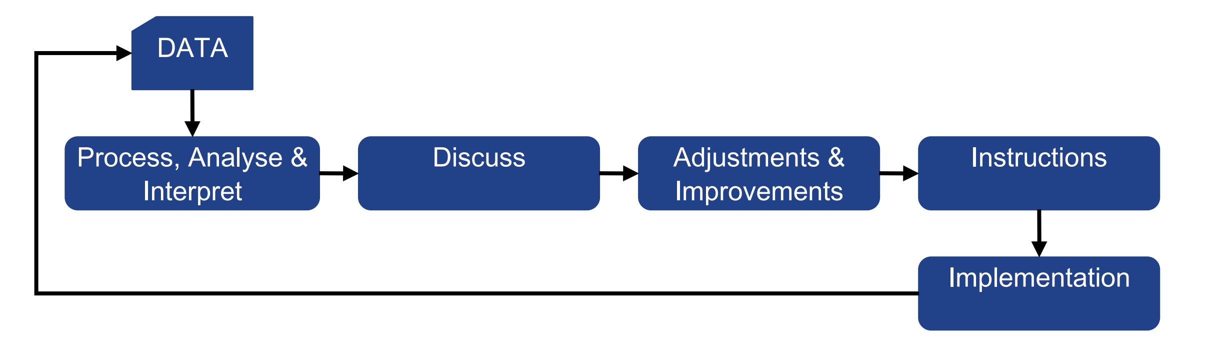


Figure 4.4: Communication of data

4.3 Practical implementation

To get an overview of the initial status of the farm a zero assessment can be carried out. The zero assessment gives inside in what are points of attention and where further improvements can be made to optimize farm processes. An example of a zero assessment can be found in Annex 1. To compare your company to international or local standards, a benchmark can be used. An example of a benchmark for Ethiopia can be found in Annex 2. In the next sections of this chapter an overview is given of what kind of data needs should be recorded on the farm.

4.3.1 Weather and greenhouse climate

The climate conditions inside and outside the greenhouse can be measured with all kind of measuring equipments, ranging from advanced, high-tech professional devices with associated software packages to more simple, basic and easy to use devices. Regardless of what kind of system you use, it is very important to know at all time what is the climate inside and outside the greenhouse in order to make adjustments in any extent possible to prevent damage to the crop or to optimize climate conditions in favour of the crop. At least the variables listed in table 4.1 should be measured and recorded.

Table 4.1: Data recording outside and inside the greenhouse

Weather station (outdoor)	Greenhouse climate (indoor)
- Temperature (°C) - Relative humidity (%) - Radiation (J/m^2) - Wind speed (m/s) and wind direction - Absolute air pressure (mBar)	- Temperature (°C) - Relative humidity (%) - Vapour Pressure (VD)

The recorded data can be converted into different kind of graphs that show additional information like trend lines, minima and maxima, or daily averages (see Annex 3). This information can be interpreted by the farm manager, crop specialist or consultant and gives a very good overview of the current situation inside the greenhouse in order to decide on actions to be taken. Based on climate information also a prediction can be made on possible emergence of pests and diseases (e.g. botrytis, downey mildew, spider mites).

4.3.2 Fertilization

Before a (base) fertilization plan can be formulated, first soil samples (in case of soil based systems) or water samples (hydroponic systems) have to be taken for chemical and physical analysis. The samples should be analysed by a certified soil analysis laboratory to obtain reliable results.
The best analysis for soil samples is the Spurway analysis. The Spurway method analyses the amount of readily available nutrients (major and trace elements) in the soil and provides more information about the nutrient buffer the soil contains. The Spurway analysis has a more direct relation with the crop's performance than general soil analysis, as a general soil analysis only shows the amount of nutrients that are available to the crop (example of Spurway analysis see Annex 4). Additionally an analysis for general soil characteristics can be done (soil classification, organic matter percentage, clay content, CaCO3 content and pH-KCl).
When a hydroponic system is used, source water (bore hole / reservoir) and drain water samples have to be taken for analysis (example of water analysis see Annex 5). In any case, soil or water analysis should at least include:

- Nutrient composition (major and trace elements)
- Electric conductivity (EC)
- Acidity level (pH)

Based on the interpretation of the Spurway analysis (or any similar soil analysis) or water analysis, a fertilization regime can been composed. In order to get sufficient insight in the soil and water conditions and to make adjustments to the fertilization regime when needed, soil and water analysis should be done regularly (see table 4.2). Interpreting of the soil or water analysis and calculation of a fertilization regime requires specific knowledge (Example of fertilization regime see Annex 6). Additionally, especially in case of hydroponic systems, it is very important to check EC and pH more frequent (every week). This can be done with more simple tests or sensors. For more information on fertilization and practical implementation, see chapter 7.

Table 4.2: Soil and water analysis period

Sample	Analysis period
Soil	Every three months
Bore hole water	Every year
Reservoir water	Every month
Drip water	Every month
Drain water	Every month

4.3.3 Irrigation

Irrigation strategy is based on climate data (radiation), evaporation of the crop, soil water content and/or drainage. Therefore, at least the following irrigation variables should be measured and recorded:

- Radiation (J/m^2)
- Irrigation (volumes, number of rounds)
- Drain (%)
- Evaporation
- Water EC and pH (irrigation & drain)
- Soil EC and moisture content

Based on this information, and combined with the soil and/or water analyses, an optimum irrigation scheme is calculated, including daily water volumes, starting and ending times of drip irrigation and number of rounds. For more information on irrigation and practical implementation, see chapter 7.

4.3.4 Crop protection and spraying

Crop protection strategy is based on recorded scouting for pest and diseases, recorded spray history and weather forecast. Based on this information the crop protection manager or specialist can give spraying advice on when to spray, how much to spray, what chemicals can be used and whether to take preventive or curative actions. Included in the spray program are measurements to prevent the development of resistance, by using chemicals from different functional groups in alternating cycles. The spray history record should contain the following information:

- Date & time of application
- Temperature greenhouse
- Name of pest / disease
- Development stage of pest / disease
- Chemical name and active ingredient
- Concentration and amount applied
- pH of the solution
- Application technique
- Resistance
- Price

An example of a spray history form can be found in Annex 7. An example of a scouting form can be found in Annex 8. For more information on crop protection and practical implementation, see chapter 8.

4.3.5 Product quantity and quality

Keeping records of crop production provides the information needed to make a comparison between actual production and required production and to subsequently calculate the company's turnover and profitability. Also rejected exports and not market production should be recorded and included in the data records to give an overview of the crop's total production capacity (in biomass) and to provide information on the impact of adjustments made to improve the production process to lower these percentages. Data that is recorded and subsequently calculated include, for each variety separately and averages of all varieties:

- Production in stems m^{-2}
- Production in grams m^{-2}
- Average stem weight in grams $stem^{-1}$
- Average stem length in centimetre
- Percentage of rejects (before and after export)
- Percentage of no market (before export)
- Average price $stem^{-1}$ in € or birr
- Yield m^{-2} in € or birr
- Yield kg^{-1} in € or birr

For an example of a production form see Annex 10.

4.3.6 Stock

Control over a well organised stock of fertilizers and crop protection chemicals is essential for quick respond to crop nutrient demands or occurrence of pest and diseases. If fertilizers or chemicals are unavailable or insufficient at times when needed, critical damage can be caused to the crop and production will be lost. Therefore at least all essential fertilizers and crop protection chemicals should be kept in stock, in sufficient quantities, at all time. An inventory system with stock lists will keep track of the available fertilizer and chemical products at any time and provide information on when to re-order stock products. Re-ordering can be based on minimum stock level (re-order when this level is reached for a certain product) or by regular stock review (make a regular inventory of the stock and re-order to fill up the stock to a predetermined level). The decisions on the kind of products and the minimum/maximum amounts to keep in stock will depend on fertigation regime, spray schedule, local or import availability of products, product delivery period, season of the year and available cash flow. A good stock control ensures that cash flow is not tied up unnecessarily and production is protected if

problems arise with the supply chain. Additional information on which chemicals to use against which specific pests or diseases, containing active ingredients, prescribed concentrations to apply, cost prices and recommended stock amounts (per hectare) are part of the stock administration.
An example of a chemical stock list can be found in Annex 9.

4.3.7 Auction and market data

Access to market information on prices and quantities plays a crucial role in reducing the risk of losses on a market transaction and provides information to make strategic decisions. High risks lead to high marketing costs, as high margins are necessary to compensate for possible losses. In some cases, farmers with accurate market information can decide whether or not to harvest and export, in order to avoid sending products to markets in times of high supply and low demand, with prices that do not cover production, packaging and transport costs.
However, information cannot be perfect. In general prices change faster than the available information, which serves more as a guide to likely returns. Furthermore, it should be kept in mind that by supplying on regular basis high quality flowers, instead of only supplying in periods of high prices, will contribute to you company’s reputation.

5 Greenhouse types and climate management equipment

5.1 Introduction

Only around 2004 the horticulture sector in Ethiopia began to develop and expand. Therefore greenhouses in Ethiopia are relatively modern in terms of building materials used. A typical (commercial) rose greenhouse in Ethiopia is made of a metal frame and plastic film coverings without special properties. The climate inside the greenhouse relies on natural ventilation through top windows, which can be both adjustable and fixed open, and flexible side screens. Inside ventilators may stimulate air circulation. Temperature control is passive through window ventilation. Sometimes top covers and side screens are controlled by a basic computerized climate management system. Fertigation is computer-controlled, but water is not re-circulated. Irrigation water originates from either rain, surface water or bore holes. Use can be made of water storage.

5.2 Theoretic background

The basic functions of a greenhouse are to provide a good climate for the crop, and to enable good crop management. Hard winds and rains outside the greenhouse can not affect the crop, and levels of radiation, temperature, CO_2 and air humidity can be controlled (although this of course depends on the greenhouse type and equipment installed to control the climate). The availability of water and nutrients can be controlled with a (computer-operated) installation.

The growing environment of a crop must be divided in two parts: the above-ground environment and the below-ground environment. The above-ground environment is determined by the levels of radiation, CO_2, temperature, and air humidity (see chapter 2). The below-ground environment is characterized by the availability of water and nutrients, and by the growing media (see chapter 6).

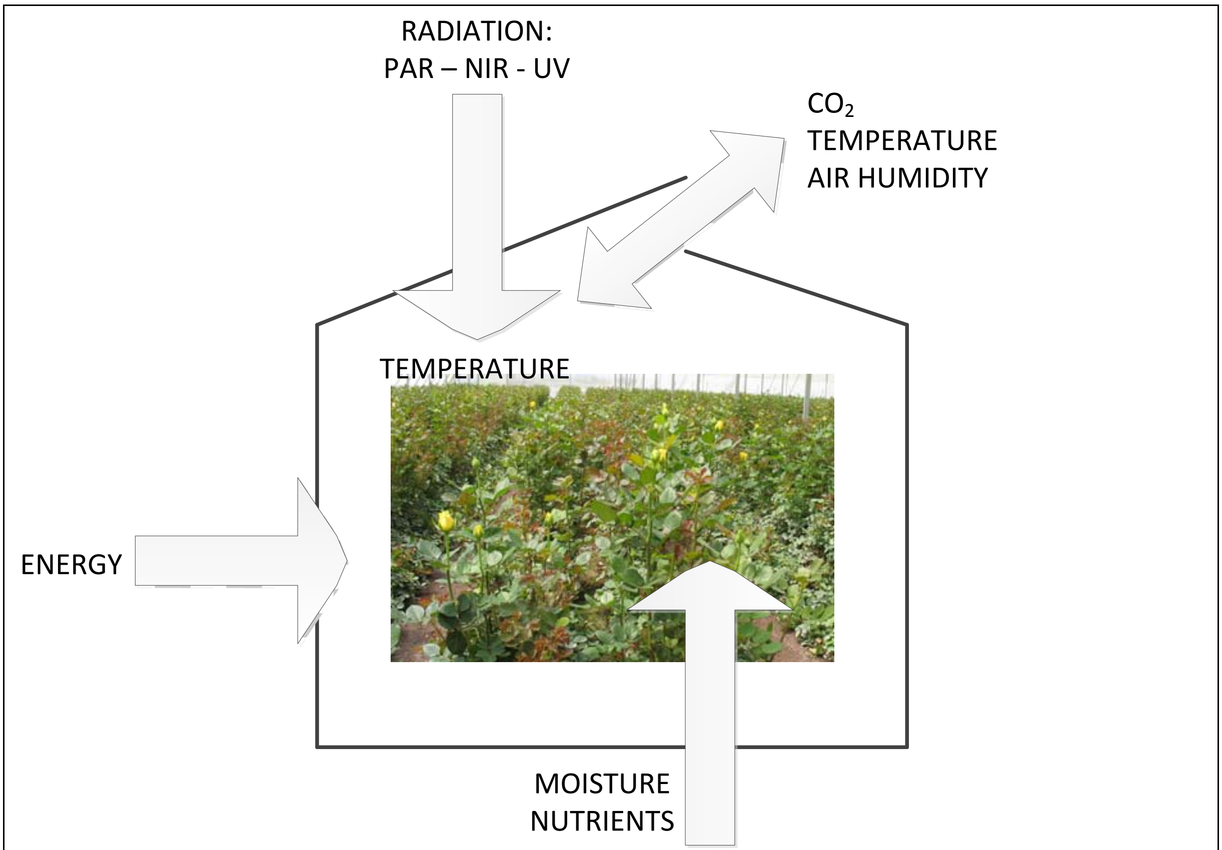


Figure 5.1: A greenhouse is a great tool to manage the climate. Radiation, CO_2, temperature, air humidity, the availability of water and nutrients can all be managed.

5.2.1 Greenhouse and climate

Within the greenhouse, depending on the installed equipment and greenhouse type, several climatic factors can be controlled directly or indirectly, i.e. radiation, carbon dioxide (CO_2), temperature, relative humidity (RV), water and nutrients, water sources and energy. In this section these factors are briefly explained.

Radiation

Radiation consists of Photosynthetically Active Radiation (PAR), Near Infrared Radiation (NIR) and Ultra Violet Radiation (UV). The greenhouse cover and the greenhouse structure should allow maximum transmission of PAR. NIR and UV carry much heat. This may be useful on dull days, but cause high air temperatures on sunny days. Diffuse plastic and shading nets are techniques to reduce the heat load under Ethiopian conditions. Advanced glass and plastics are available on the market, and are suitable for more advanced greenhouses.

Carbon dioxide (CO2)

CO_2 is with PAR the most important factor that determines crop growth and production. As a crop can consume quite large amounts of CO_2, this must be replenished. Industrial CO_2 is not available in Ethiopia, so the only solution is to maintain natural air ventilation through the open windows. This can be supported with mechanical ventilation inside the greenhouse. In Ethiopian regions at higher altitudes, greenhouses are occasionally heated. The combustion generates CO_2, however, this can not be used if oil is the source of energy as also too many poisonous gasses are produced.

Temperature

Temperature does not have very much effect on the photosynthesis of the crop, as long as the temperature remains between 20 and 35^oC. Temperatures can be high in Ethiopian greenhouses but due to the heat load of the incoming radiation. Active cooling is not really an option because of the high energy costs. The temperature must be low through natural window ventilation, and through evaporative cooling by the crop. This is one of the reasons why it is important to maintain a crop with sufficient foliage and to irrigate well (for which an adequate installation and software are required).

Relative humidity (RV)

Relative humidity of the air, or for more precise measurements the vapour pressure deficit (VPD), influences for example stomatal opening, and pest and disease development. RV is the amount of water vapour in the air; VPD is the difference (deficit) between the amount of moisture in the air and how much moisture the air can hold when it is saturated. The advantage of using VPD instead of RV is that the VPD is more precise, as the value is adjusted for temperature differences. If the temperature rises, the air can contain more water vapor. At higher temperatures, the RH is lower and the moisture deficit increases. RV or VPD should not be extreme, while otherwise stomata will close and photosynthesis will come to a stop. In Ethiopia the relative humidity in the greenhouse can be controlled by good ventilation options or by brushing.

Water and nutrients

Water and nutrients are made available through an automated fertigation system. This is standard in Ethiopia. Assuming that the hardware is good, it is the settings that are critical. In the ideal situation, there is always just sufficient water and nutrients available in the soil or substrate. This is best achieved by a high number of small fertigations over the day on the basis of settings that are based on sensor information. Recirculation with disinfection, use of rain water and sufficiently large basins are water-saving technologies that can be relatively easy to implement.

Water sources in Ethiopia now are surface water, bore hole water and rain water. Growing on substrate, recirculation and disinfection are rare. Their implementation would mean serious reduction in water use.

Energy

A greenhouse consumes a fair amount of energy. In Ethiopia, this means electrical energy. This can be obtained from the net, but the use of solar panels is a serious option, as solar energy is for free, after all. At the moment, regular power failures is one of the problems to deal with in Ethiopia

5.2.2 Technology level of a greenhouse

In table 5.1 an overview is given of the different technology levels in a greenhouse. Three different levels have been specified, i.e. standard-tech, above standard-tech and high-tech (Dutch standards), with for each standard the technology options for each controllable greenhouse element. Figure 5.2 shows the possible components of an Ethiopian greenhouse.

Table 5.1: An overview of technology levels for different elements in a greenhouse

Element	Standard-tech	Above standard-tech	High-tech (The Netherlands)
Light	Plastic greenhouse cover; shading nets.	Plastic greenhouse cover with diffuse properties; shading nets.	Glass, standard or with anti-reflection and diffusing properties; assimilation lighting.
CO_2	No / fixed window opening, without flexibility in CO_2 inlet	Flexible window openings to maximize CO_2 inlet if necessary; mechanical ventilators inside the greenhouse.	Industrial CO_2
Temperature	No / fixed window opening; passive, natural ventilation	Flexible window opening; passive, natural ventilation.	Flexible window opening; active cooling or heating.
Air humidity	Fertigation on fixed hours, leading to water shortage during mid-day.	Automated increase of fertigation frequency during mid-day, maintaining high transpiration.	Air treatment unit
Water	Fertigation on fixed hours; use of EC.	Fertigation on the basis of radiation sum; use of EC.	Water content sensors provide information on the soil/substrate status to the computer; shortages are replenished.
Water source	Surface water	Surface, bore hole and rain water; basins; recirculation with disinfection	Surface, bore hole and rain water; large basins; water purification before using; recirculation with disinfection; minimal drain
Climate homogeneity	Only natural ventilation	Mechanical ventilators	Greenhouse dimensions specifically determined; top or bottom air supply; air treatment units
Nutrients	Fertigation on fixed hours; use of EC.	Fertigation on the basis of radiation sum; use of EC.	Ion-specific sensors provide information on the soil/substrate status to the computer; shortages are replenished
Energy	Low requirement; obtained from the net	Higher requirement; obtained from the net	Highest requirement; obtained from the net and from solar panels; WKK installed
Automation	No automation or time-clock	Computer-based fertigation; some climate registration	Computer-based fertigation and climate management; climate and other sensors.
Approximate costs	€20 m^{-2}	€30-40 m^{-2}	€100 m^{-2} (or more)

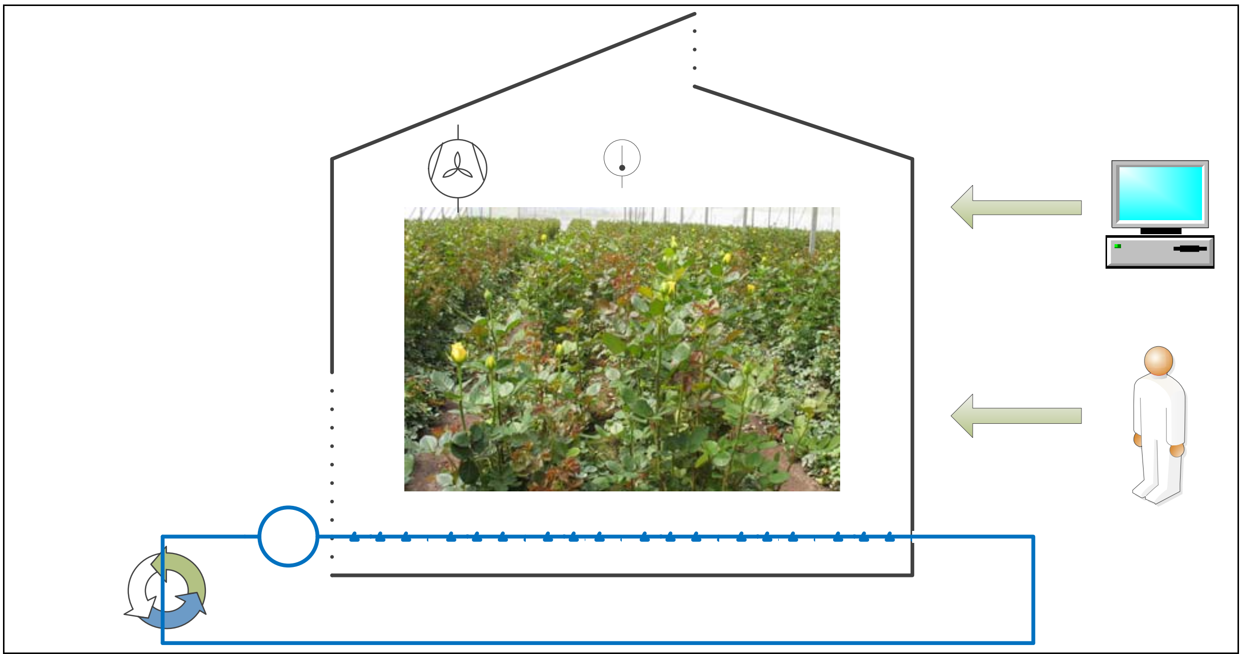


Figure 5.2: Possible components of an Ethiopian greenhouse

5.3 Practical implementation

Deciding on what type of greenhouse to build, and where to build it, depends on many factors. Although there are advantages in each type of greenhouse for a specific application, in general there is no single greenhouse, which can be qualified as the best. Greenhouses are designed to meet specific needs depending on utility and location.

Classification of different types of greenhouses can be made on shape, material, construction, ventilation and utility. Shapes include even span, uneven span, ridge and furrow connected, sawtooth, arch, tunnel, and Quonset greenhouses. Materials for the framework construction include wood, steel and aluminium and cover material include glass, fibre glass and plastic film. Ventilation options include fixed vent, fixed vent with roof curtain, adjustable vent, single roof vent, double roof vent, closed roof vent and fixed or adjustable side screens, supplemented with insect screens.

In Ethiopia the most common greenhouse type is a basic greenhouse with steel construction, covered with plastic film (mostly polythene), with fixed or adjustable single roof vents and fixed or adjustable side screens. Greenhouses with fixed vents are cheaper, but provide fewer options for controlling the humidity inside the greenhouse. Another reason to choose for fixed vents is to not be depended on electricity to open or close the vents (in case of electricity failure, although they can also be manually controlled).A plastic film covered greenhouse is the cheapest option available, as it requires simple and light structures and thus low material (transport) costs. A disadvantage is that the plastic film needs to be replaced regularly, as it will deteriorate in time. Sizes of the greenhouses may vary, depending on age, from 6.40 - 9.60m wide in span for individual bays, 4.0 - 6.5m ridge height and 2.5 - 5.0 gutter height. The tendency exists to build larger greenhouses, to maintain a more constant climate.

Greenhouses in Ethiopia are mainly constructed by greenhouse construction companies from France, India and Israel. All greenhouse construction materials need to be imported from abroad.

insect screen

5.3.1 Choice of location

In choosing the location for a greenhouse, there are several aspects to consider:

- *The land surface:* the land should have a smooth and levelled surface; a light slope may be be created to give possible excess water or stagnated water the opportunity to drain off
- *Chemical and physical composition of the soil:* if a soil based system growing system is practiced, mineral content of the soil and water holding capacity are important
- *Availability of electricity:* an electricity connection is necessary to operate greenhouse equipments, computers, etc.

pump

- *The availability and quality of water:* a reliable and qualitative source of water is necessary for irrigation (surface or ground water, supplemented with rain water collection).
- *Altitude:* depending on the rose variety
- *Good accessibility by road:* make sure the farm is accessible by a paved road to facilitate easy transport of materials, supplies and products; preferably the farm is located relatively near to the airport

5.3.2 Greenhouse construction

Deciding on the type of construction for a greenhouse, there are several aspects to consider:

- *Size of bays and spans:* bays and spans should be as wide as possible to reduce shading of the structure and to maximise light levels
- *Orientation of the greenhouse:* orientation is determined by the direction of the greenhouse roof ridge, relative to the line of movement of the sun. Around the equator, uniformity of light distribution and total yearly light received will be greatest if the greenhouse is oriented with a North to South roof ridge. Futhermore, greenhouse orientation is important for ensuring good ventilation, which is in relation to the predominant wind direction
- *Shape and angle of the greenhouse roof:* curve shaped and asymmetric roofs use the light most efficient; if solar radiation reaching the greenhouse roof at an angle lower than 15-20°, it will largely be reflected
- *Draining system rainwater:* efficient handling of rainwater reduces the potential for erosion and flooding; collected rainwater can be used for irrigation purposes
- *Framework:* materials that can be used for framework construction are steel, aluminium and wood; wood is hardly used anymore (outdated greenhouses; high maintenance), aluminium is durable but expensive, steel is cheaper than aluminium and relatively durable.
- *Covering material:* Most common materials used are Polythene (PE), Polyvinyl Chloride (PVC) and Ethylenvinylacetate (EVA). For more details on films see section 5.3.3 below.

5.3.3 Greenhouse film properties

In choosing the greenhouse film cover, there are several aspects to consider:

- *Durability:* Greenhouse films exposed to outdoor environment for prolonged periods are susceptible to degradation as a combined effect of sunlight, heat and interaction with crop protection chemicals; special chemical additives (uv-stabilizers) incorporated into the polymer matrix provides a longer lifetime and protects the film from photo as well as thermal degradation; painting the film cover above the metal framework of the greenhouse white, will reflect the sunlight and reduce the heat of the metal and thus prolonging the life of the film.
- *Mechanical properties:* mechanical properties include properties that reduce damage to the film (impact strength, tear resistance) and are associated with thickness (thickness may very from 0.05-0.25mm)
- *Light transmission:* To reduce the intensity of direct sun rays, special mineral fillers in the polymer can diffuse the light, scattering the direct rays (e.g. preventing leaf burn); uv-stabilizers protect against harmful uv-radiation entering the greenhouse
- *Anti condensation and dripping:* water droplets forming on the inside of the film due to condensation causes hindrance to proper light transmission, and crop damage (e.g. burning of leafs; rays passing through droplets are increased as they act like a lens); falling water droplets can causes diseases (e.g. botrytis)
- *Thermal capacities and insulation:* to prevent radiation loss during the night (temperature outside the greenhouse lower than inside), mineral fillers or special polymers can be incorporated in the film.
- *Anti-dust:* special additives, which migrate to the surface of the film, can prevent accumulation of dust and keep the film clean.
- *Monolayer and multilayer films:* multilayer films can combine different properties, by combining different film layers

5.3.4 Examples of greenhouse types

In the figures below, several examples are given of different greenhouse types and technology levels.

Figure 5.3: Common greenhouse in Ethiopia

Figure 5.4: Ventilation system in Ethiopian greenhouse

Figure 5.5: Greenhouse in Colombia with open sides and fixed open top covers

Figure 5.6: Interior of a Colombian greenhouse

Figure 5.7: Fully closed greenhouse in Asia with no ventilation (very high temperatures inside)

Figure 5.8: Greenhouse in Malaysia with side and chimney ventilation (good temperatures inside)

Figure 5.9: A Venlo glass greenhouse in The Netherlands

Figure 5.10: High-tech Netherlands greenhouse with assimilation lights

6 Management of growing media

6.1 Introduction

Two general growing systems are used in Ethiopia: soil based and hydroponic. The majority of the rose production in Ethiopia is on soil based systems. Only approximately 10% is grown on hydroponics (cocopeat or red ash).
In Ethiopia, four principal rose cultivation areas can be specified, based on average altitude and soil type: 1) Ziway (sandy soil, 1650m), 2) Debre Zeit (light clay soil / black cotton soil, 1950m, 3) Holeta (black cotton soil, 2500m) and 4) Sebeta (black cotton soil, 2250m).

6.2 Theoretic background

6.2.1 Physical soil characteristics

Soil physical properties are those related to the size and arrangement of solid particles, and to the way liquids and gases move through soils is affected by these particles. Soil in general consists of four components (see figure 6.1): air, water, minerals and organic material. Soil mineral particles are derived from the weathering of rocks and minerals; soil organic matter is the product of microbial decomposition of the remains of plants and animals.

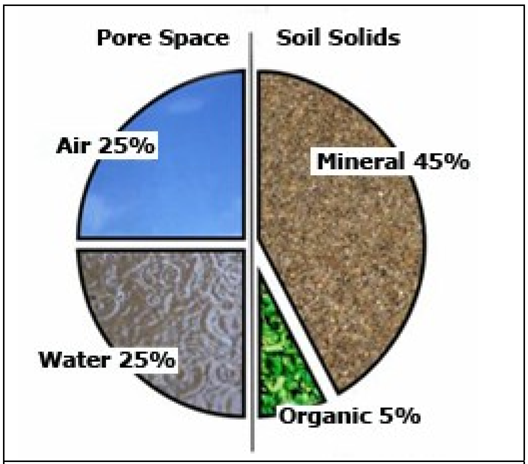


Figure 6.1: Soil components with overall averages

Soil texture

Soil texture refers to a particular soil's distribution of mineral particles within certain size ranges. In general three main soil textures can be classified, based on particle size: sand (2.0 – 0.05mm), silt (0.05 – 0.002mm) and clay (< 0.002mm). Based on mixtures of the three main soil textures, different soil types can be identified. This is shown in figure 6.3.

Soil structure

Soil structure refers to the arrangement of the primary particles into clumps or aggregates. Soil organic matter is generally involved in binding particles into stable aggregates. The amount and arrangement of aggregates determines the total porosity of a soil, being a combination of mineral particles, organic matter, and pore space. The lower the porosity, the lower the total pore space available for air and water within a soil. Porosity of a soil typically decreases as particle size increases (see figure 6.2). On the other hand, organic matter increases soil porosity.

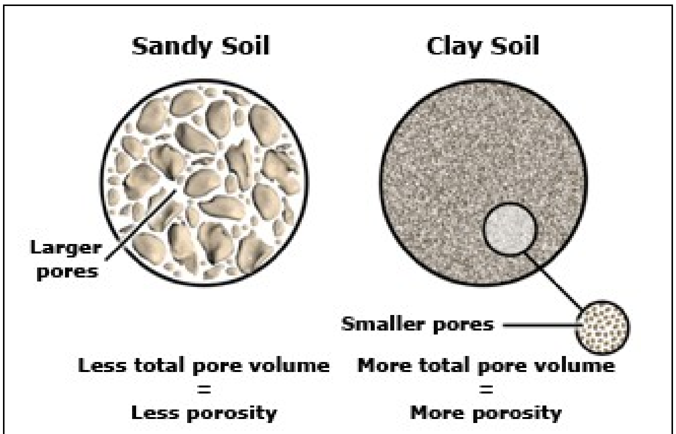


Figure 6.2: Pore space is sandy soil vs. clay soil

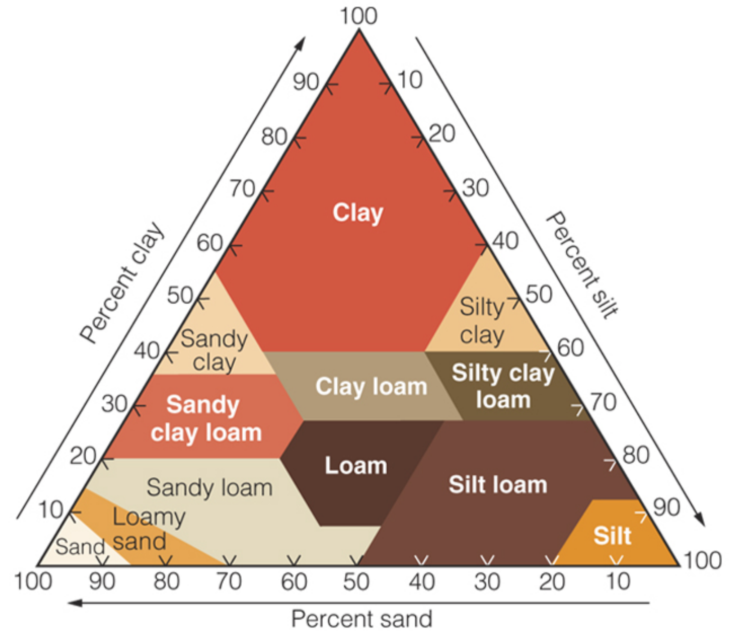


Figure 6.3: Soil textural triangle, classification of soil by means of percentage sand, silt and clay

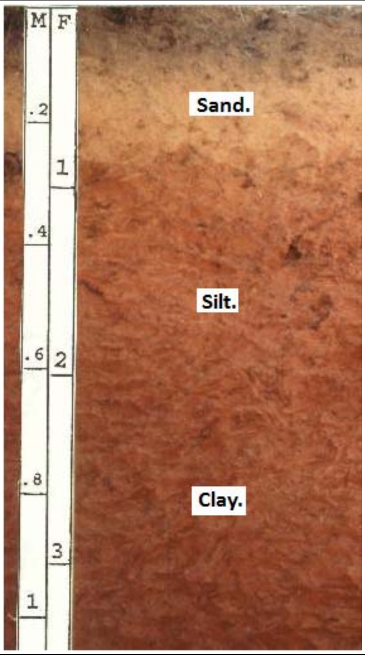


Figure 6.4: Different soil textures in one soil layer

Macro- and micro-pores

A soil suitable for plant growth includes characteristics that offer little resistance to plant root penetration and also provide sufficient oxygen and water for the plant's roots. A proper proportion between water and oxygen has to be maintained to ensure the roots have enough water at their disposal, but also are able to dissimilate. A good balance between macro-pores and micro-pores is therefore essential. Macro-pores permit infiltration and drainage of water; micro-pores store water for future plant needs. Capillarity is closely linked with pore sizes and refers to the ability of small pores to retain water against the force of gravity and results from the adhesive forces between water molecules and the particles in soil and from the cohesive forces between water molecules. Because small pores tend to be water-filled due to capillarity, fine-textured soils with little structure and large amounts of micro-pores may provide inadequate oxygen for plant growth. Oxygen diffuses rapidly through air-filled pore space and slowly through water-filled pore space. Mechanized agricultural practices tend to destroy soil structure and compact soils, resulting in poor tilth. Compaction results from the pressure exerted on soils by heavy equipment moving over them. Agricultural practices also tend to destroy organic matter in soils that is needed to maintain structure.

Water availability, water holding capacity and permeability

The amount of water available to the plant differs per soil type and can be visualised in a water retention curve (pF curve) (see figure 6.5). A water retention curve is the relationship between the water content of the soil and the soil water potential (which quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure, or surface tension). Two concepts are important with regard to soil water availability to the plant: field capacity (FC) and wilting point (WP) (see figure 6.6). Field capacity is the amount of soil moisture

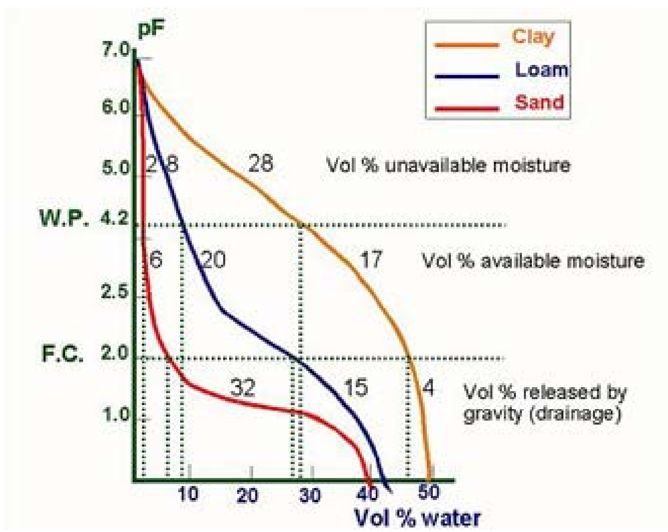


Figure 6.5: Soil moisture retention curve for clay, loam and sand

or water content held in soil after excess water has drained away and the rate of downward movement has stopped. Wilting point is defined as the minimal point of soil moisture at which the plant can still absorb water from the soil in order not to wilt. If moisture content decreases below the wilting point a plant can not absorb water from the soil anymore, can no longer recover its turgidity and will wilt eventually. If the moisture content increases above field capacity oxygen soil levels will be minimal and will negatively affect the roots. As you can see from figure 6.6, both field capacity and wilting point are relatively low for sandy soils as compared to clay soils. A tensiometer can be used to measure the water content of soil (or substrate), in order to keep track of and control the right soil moisture content.

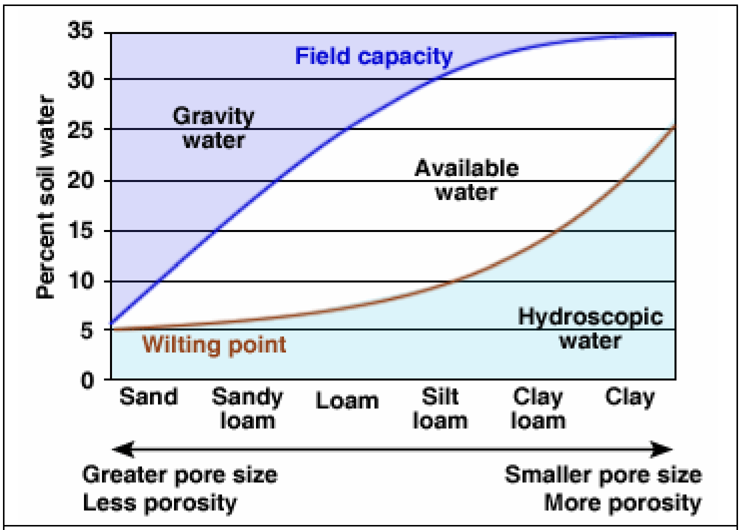


Figure 6.6: Soil moisture availability for various soil textures

Porosity of soils and level of macro- and micro-pores greatly influence permeability and water-holding capacity of soils. Sandy soils (low porosity) have low moisture retaining capacity and high permeability (water and air). Soils with high clay content (high porosity) have high moisture retaining capacity and low permeability (water and air). In clay soils a high percentage of the total pores are micro-pores that do not permit rapid water movement. Therefore water infiltrates slowly into, and out of, these high-clay soils. Sandy soils, with a higher percentage of macro-pores, have a high water infiltration rate. Water moves rapidly through the profile.

6.2.2 Physical soil requirements for rose cultivation

Roses can be grown on various types of soil; clay, peat and sandy soils are all suitable. In general, a soil suitable for rose cultivation in greenhouses has the following characteristics:

- Good, homogeneous, stable structure
- Able to hold sufficient air in wet conditions
- Good permeability
- Homogeneously structured soil profile
- Good drainage and constant groundwater level

These characteristic are further explained below.

Good Structure

To ensure optimal air and water management, the soil particles must contain sufficient macro-pores and micro-pores. The macro-pores facilitate the water transport in the soil. The micro-pores help retain moisture. The root growth decreases (and the diameter increases) as the penetration resistance of the soil increases.

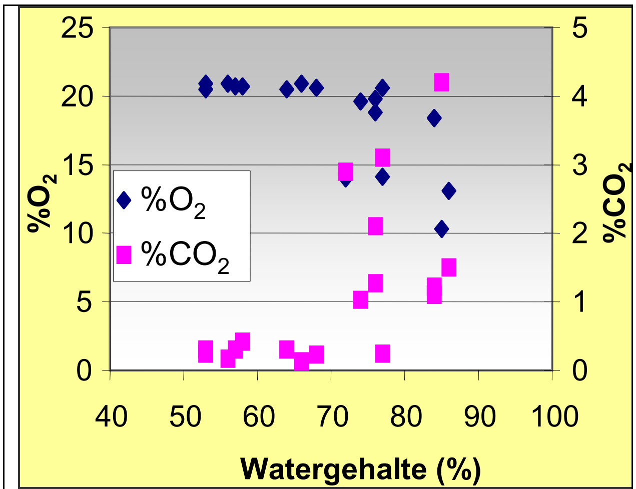


Figure 6.7: The Oxygen and CO_2 concentration in a substrate is influenced by the water content (Wever, 2004)

Air exchange capacity in wet conditions

Oxygen is important for the roots as 25 to 50% of the carbohydrates formed by photosynthesis are transported to the roots. The oxygen use by the roots increases with increasing plant size and it is several times higher in the light period than in the dark period. The roots use these sugars for growth, ion uptake and root respiration (release of CO_2 by the roots). The diffusion of gases is faster in the air than in the water. Too little air leads to local exhaustion and accumulation of gases in soil or substrates with high water content. Consequently, pores in the root medium are important for the exchange of gases. A medium (soil or substrate) with sufficiently high air content is of key importance for an undisturbed root development. This is not only for the oxygen supply: CO_2 accumulation has an inhibiting effect on root growth in concentrations of 3 to 5 % (compared to 0.03% in the outdoor air). The same applies to ethylene accumulation. Figure 6.7 shows the oxygen and CO_2 concentration in a substrate as influenced by the water content.

Permeability
Good permeability is extremely important to quickly drain the water to the subsoil after irrigation. Stagnant water in a profile during cultivation results in root death due to oxygen deficiency. In addition soil life does not function adequately and reduction of mineral compounds may occur (for example manganese, iron), with harmful consequences for the crop.

Homogeneity in soil profile
A homogeneous soil profile means that there are no disturbing layers. Such layers (for example a layer with heavier clay than the rest of the profile) result in disrupted permeability and affect root growth and root formation.

Drainage
A constant groundwater level of minimal 70 cm is required to allow drainage, but 90 cm is preferred. The groundwater level must be constant as fluctuations in groundwater level can affect drainage and cause root death.

6.2.3 Soil improvement

The physical and chemical properties of the soil can be improved before planting by the addition of soil improvers: the most common are organic matter, lime and gypsum or sulphur.

Organic matter
Organic matter increases the moisture retaining capacity of the soil, and reduces the sensitivity to panning of the top layer (slaking). Annex 11 gives an overview of organic matter from different sources. Waste products that are sold as fertilizers or soil-improvers should be carefully monitored by the user. They should not contain high amounts of e.g. phosphate, heavy metals and dioxine. Instead of fertilizing one may be dumping waste! Organic matter decomposes in the soil by the action of micro-organisms. The decomposition process:

- Releases CO_2 that may contribute to the increase of the CO_2 content in the greenhouse air.
- May also result in oxygen deficiency when ploughed in too deep.
- Under too wet conditions certain organic matter such as straw, green manure and shredded crop debris may lead to the release of phenols and fatty acids which inhibit root growth.
- Fixes nitrogen which may result in nitrogen deficiency.

Lime
Lime (calcium carbonate, $CaCO_3$) provides sufficient buffer to prevent a pH drop in the soil. At too low pH few calcium ions are available on the soil particles and the structure becomes too compact. When the $CaCO_3$ is too low, liming is required. These soil improvers are used to correct pH in alkaline soils, which are soils with a too high pH. At high pH some microelements can not be taken up by the plant.

Gypsum & Sulphur
Gypsum (calcium sulphate, $CaSO_4$) is used to improve the structure of the soil, and to reduce salinity in soils rich in sodium, as the ion Ca^{2+} is exchanged in the complex by Na^+. Sulphur reacts with sulphur bacteria in the soil and transform to sulphuric acid, which acidifies the soil.

Soil tillage
Tillage should be restricted as much as possible, since it mostly is at the expense of the soil structure. The only recommended action is digging. The soil is loosened to a depth of about 30cm. The soil

should not become too fine, therefore milling is not recommended. Only when disturbing layers are observed in the profile, it is recommended to carry out tillage to about 80cm. In all cases after deep soil tillage light digging and levelling of the top layer is necessary.

6.2.4 Other growing media

Roses can be grown on different growing media than soils (hydroponic). With choosing a type of substrate, keep in mind the following requirements (see also figure 6.8):

- Give enough support to the plant
- Low bulk density (see table 6.1)
- Sufficient pore space (see table 6.2). Pore space determines water content, air content, good water and air distribution; oxygen diffusion in the substrate slows down at 30% air filled porosity (figure 6.9).
- Good water holding capacity (function of the total pore space)
- The capacity to rehydrate after (moderate) drought
- Good drainage capacity
- Sufficient durability (if the material loses volume, bulk density increases, total pore volume decrease, water retention increases, oxygen transport becomes slower)
- Easy manageability, good availability and low cost

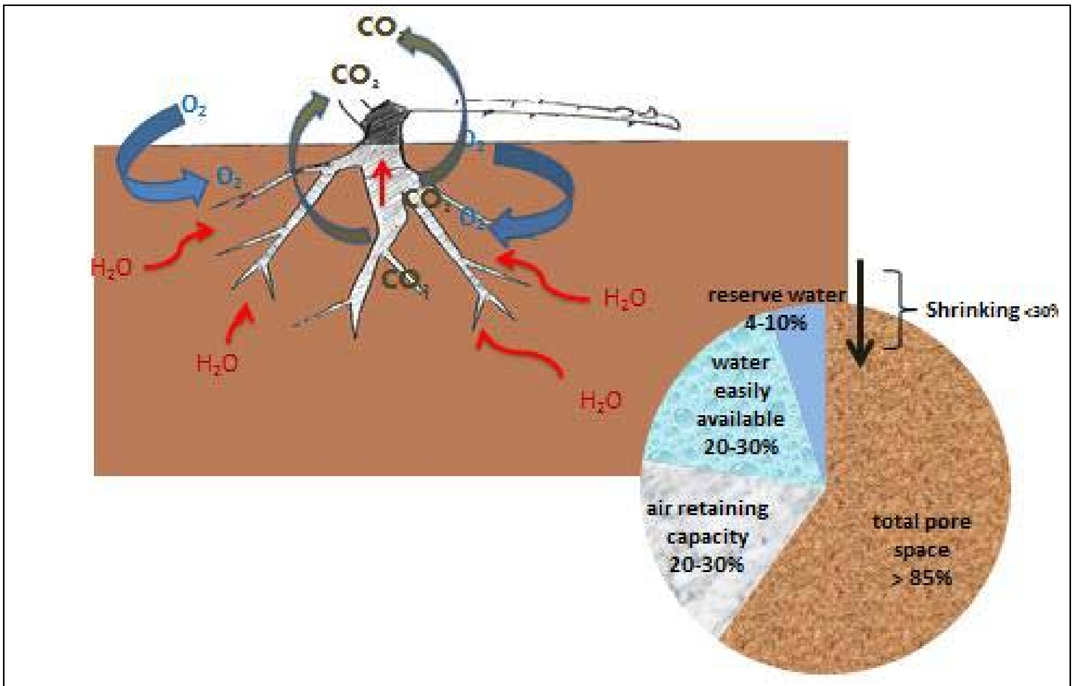


Figure 6.8: Root requirements and physical properties of a good cultivation substrate

Table 6.1: Bulk density of some substrate

Sample	Bulk density (kg.m^{-3})
Soil	1500
Clay balls (0-4mm)	650
Turf	350
Rock wool	70

Table 6.2: Total pore volume in % of substrate volume

Substrate	Total Pore volume (%)
Glass wool	98
Rock wool	97
Perlite	96
Polyurethane	95
Coco dust	95
Turf	91
Pumice	83
Clay balls	76

Figure 6.9: Effects of anoxia in the substrate; left normal, right oxygen deficient roses

Mineral growing media

Suitable substrates of mineral origin for roses (pumice, perlite, expanded clay, rockwool, glasswool) have little effect on the chemical composition of the substrate moisture. There are, however, materials available in which the salt content can be too high. To avoid problems a substrate should be analysed by an expert before using it. Pumice is a substrate of volcanic origin. Perlite is roasted volcanic rock. Both have a small water buffer and require a high frequency of water supply to avoid drought stress and realise sufficient renewal of the nutrient solution. Watering should be done from above because the capillary effect is small. Due to very coarse pores in the coarser versions of these materials, oxygen supply is not a problem.

Organic substrates of natural origin

To this group belongs cocopeat, a product of vegetable origin mostly coming from Sri Lanka. There are not many other organic substrates with sufficient durability for rose cultivation. Organic substrates are deteriorating because the material oxidises, partly by micro biological activity. There are many variations of these substrates available, from coarse to fine and from fibrous to granulated material. This means that there are many different physical characteristics. Cocopeat generally contains a lot of sodium and potassium, and should therefore be pre-treated, if possible, so that these elements are superseded from the adsorption complex.

6.3 Practical implementation

6.3.1 Soil vs. hydroponic

The advantage of using hydroponic against a soil based system lies in the fact that the moisture content is more controllable. By collecting and measuring the amount of drain water, more insight is provided into when too much or too little irrigation and fertilization is given to the crop. Fine-tuning the irrigation and fertilization according to the actual crop needs, can save on water and fertilizers consumption, is better for the crop and is more environmentally friendly, as compared to a soil base system, where in general too much water and fertilizer are given.

However, using a hydroponic system also implies that the irrigation and fertigation management needs to be perfect. An excess or deficiency of water or nutrients will have greater impact on a crop growing in a contained system than in soil bases systems, as the soil has a larger buffer capacity. Because power cuts occur rather frequently in Ethiopia, uncertainty exists about the possibility to continuously irrigate and fertigate. In case of power failure irregularities in irrigation and fertigation can heavily affect the growing conditions of the crop.

6.3.2 Soil based

Soil based production is common practice in Ethiopia and therefore soil quality is an important aspect of rose production. Chemical and physical soil characteristics should be known and analyzed (see section 4.3.2), in order to adjust irrigation and fertigation and ensure good root growth and uptake of water and minerals. Sometimes organic material can be combined or mixed with the soil to improve soil properties. For example, trails with composting of biomass waste have been carried out, to improve soil structure, water holding capacity and soil fertility. Another example is the application of bone meal (crushed and coarsely ground bones, a by-product of the slaughterhouse), as a slow-release fertilizer source of phosphorus. Application of bone meal should be done with a concentration of 15 kg per 100 m^2 every 5 – 6 weeks, up to a maximum of 40 – 60 kg per 100 m^2 in total. Problem with soil based systems can be sole born fungi, nematodes and leaching of chemicals into the environment

Soil preparation

Soil preparation for planting a new crop starts with removing all residual vegetation of the previous cultivation. Prepare the soil by ploughing (at 40-45cm), followed by harrowing (at 25-35cm) to crumble the soil and create a fine basic soil structure. Additionally compost, peat or other organic matter can be added during preparation of the soil to improve the soil structure, improve soil fertility and supply nutrients. Then level the soil and possibly a light slope can be created to give possible excess water or stagnated water the opportunity to drain off. Underground drains can be installed for additional drain off. Additionally, take samples of the soil for chemical and physical analysis in order to make a plan for base fertilization. Several weeks before planting, the soil can be disinfected (steam or chemicals) to reduce the presence of weeds, nematodes, diseases and parasites. After disinfection a heavy irrigation can be applied to clear the soil from any residues.

Preparing beds

After soil preparation the next step is preparing the beds in the greenhouse, for which the following steps have to be taken:

1) Creating cultivation beds (raised; width 60cm, height 30 cm);
2) Wetting;
3) Crumbling & surface levelling;
4) Creating holes for transplanting (two rows in each bed);
5) Positioning of irrigation / fertigation tubes and connecting to main tube;
6) Start fertigation 7-10 days before planting
7) Transplantation of the rose plants (see figure 6.10)

Figure 6.10: Planting of a new rose crop

Figuur 6.11: Soil based system at Ethiopian rose farm

Fig 6.12: Hydroponic system (red ash) at Ethiopian rose farm

6.3.3 Hydroponic

Hydroponic systems are less common in Ethiopia then soil based systems. Only approximately 10% is grown on hydroponics. The hydroponic systems that are used are basic: mostly simple substrate containers, filled with cocopeat, red ash or a combination of the two (see figure 6.12). Red ash is locally produced in Ethiopia (especially in the Debre Zeit area), cocopeat is mostly imported from India.

As discussed in section 6.3.1, practicing rose cultivation on hydroponic systems is still very difficult in Ethiopia. Therefore the preferred system is still a soil based systems.

6.4 Business case: From hydroponics back to soil!

Company : Olij Roses
Location : Debre Zeyt
Production area : 12 ha
Main varieties : White Champion, Dreamland, Spotlight, Red Label, Art Deco

Olij is a Dutch rose breeder and propagator with breeding and production locations in the Netherlands, South America, Kenya and Ethiopia. In 2007 Olij Roses Ethiopia started to grow on hydroponics (coco peat) instead of directly in the soil. However, at the start of 2011 they changed back to soil. Philippe Veys, director at Olij Roses in Ethiopia, says:

"We came to the conclusion that water and fertilizer use with cultivation of roses on hydroponics (coco peat) is much higher as compared to growing in the soil, and thus entails higher production costs. On a sunny day, on hydroponics we need to irrigate about 7-8 litre water per m^2, while in the soil we only need to irrigate about 3-4 litre per m^2."

Philippe added that this also depends on the soil type cultivated on. In their location (Debre Zeyt) the soil type is black cotton soil, which has a good water holding capacity characteristic, which accounts for significant less water use as compared to coco peat hydroponics. Philippe also mentioned that still technical improvements can be made with rose cultivation in the soil in Ethiopia, like underground drainage systems or soil improvement with e.g. organic matter. Philippe continues:

"Furthermore, growing on hydroponics needs perfect management of irrigation and fertilization and a technical advanced fertigation system, as the buffer capacity of a hydroponic system is much lower as compared to that of growing in the soil. The situation in Ethiopia at the moment is as such that the technical service in case of a failure or breakdown of the system is limited and cannot be solved inmediately, which is unacceptable in case of rose cultivation and will cost a lot of production."

Philippe also observed that the crop grown in the soil is less vulnerable to especially Downey Mildew:

"Because the crop is stronger in the soil, as compared to on hydroponics, the rose crop is much less vulnerable to be damaged by Downey Mildew"

As a concluding remark, Philippe also mentioned that the price of coco peat is going up due to import regulations, which makes it even less interesting to use hydroponics.

7 Irrigation and fertilization

7.1 Introduction

Irrigation and fertilization are vital aspects of crop production. The right amounts of nutrients and water need to be supplied to the plant for optimal growth and should therefore be managed very precisely. If done incorrectly, it can have large consequences for crop production or can even damage the crop.

7.2 Theoretic background

7.2.1 Physiology of the root

Plants take up water and fertilizers through the roots. The functions of roots are anchorage, water and nutrient uptake, hormone production, transport and storage. To obtain a better insight into the factors determining the growth and functioning of roots, it is useful to know more about the external (morphological) and internal (anatomical) structure.

Internal and external structure and function

A number of components can be distinguished in a seedling or cutting from the lower end of the, root being the elongation zone, root hair zone and lateral root zone (see figure 7.1).The root tip protects the part where the cell division takes place (meristem). It is the place where chemical and physical signals are received. The elongation zone is the place where the signals of the root tip are translated into more or less elongation of the cell walls, and thus causes growth.

In the root hair zone root hairs are formed. Root hairs are epidermis cells with a short lifespan (several days) that increase the effective uptake surface of the root. Above the root hair zone, secondary roots may develop in the lateral root zone. Lignification of the outer layer of the root occurs in some crops. In roses, this exodermis is dark brown to black and can only let water and nutrients in through certain spots.

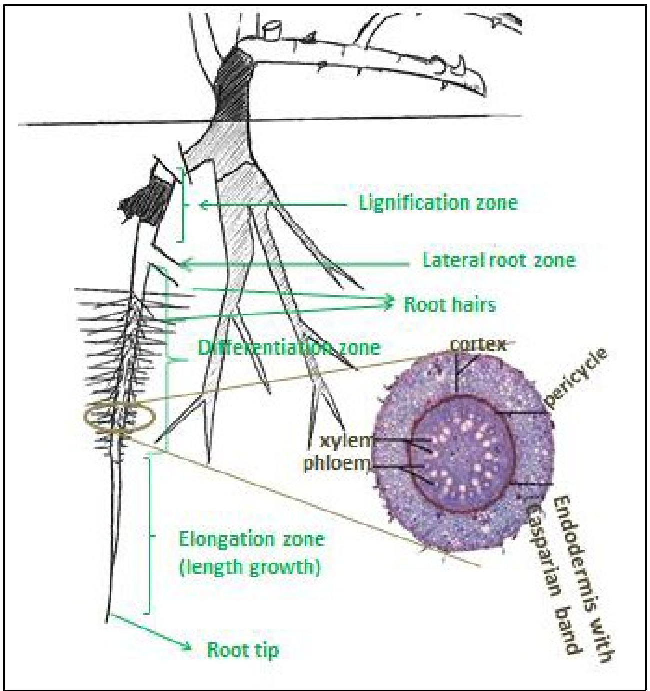


Figure 7.1: Internal and external structure of the root

Uptake of water and nutrients

The ion concentrations in the root cells are considerably higher than in the surrounding root environment. The cell membranes of the root cells are semi-permeable and therefore water is taken up through osmosis. In the root tip and the elongation zone the endodermis is not fully developed yet, so that undifferentiated uptake of water and nutrients is possible. This form of uptake is determined mainly by under pressure in the xylem vessels, developed as a result of transpiration by the leaves. For immobile elements such as calcium and boron this form of transport is very important.

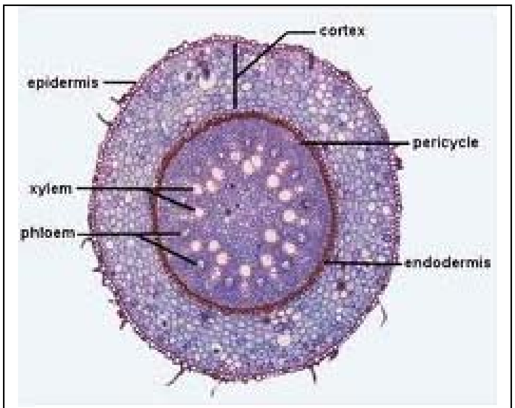


Figure 7.2: Cross section of a root

Active uptake of nutrients

Uptake of an ion often means transport against the concentration gradient; the uptake ion is exchanged by another ion with the same charge, or simultaneously taken up with an ion with opposite charge. This active uptake of ions cost energy, which is supplied by the root respiration.

The active transport of ions through the membrane is not yet completely understood. One of the current theories is the 'Carrier'-theory. Carriers are protein-like compounds, bound temporarily to an ion. They transport the ion through the membrane and then release it inside of it. Carriers can be specific for only one particular ion, for example potassium. This is the basis for selective uptake. As a result, the composition of the plant may differ considerably from the composition of the nutrient solution. The same carrier can transport also related ions, such as potassium and sodium. This is the origin of the concept of antagonism. If, for example, more potassium is present in the nutrient solution, as compared to calcium, the place of calcium on the calcium carrier can be taken in by potassium ions, which may result in calcium deficiencies.

The speed at which ions are taken up depends on the concentration in the external solution: the more ions present, the more ions are absorbed. For certain ions, such as Nitrogen, this is bound to a maximum, whereas for others, such as Boron, it is not, so that uptake continues until the plant has poisoned itself.

Uptake also takes place by the cells of the epidermis with the root hairs. The ions enter through the cell membrane. As described above, all must be transported via the endodermis to the xylem vessels. The epidermis and the lignified cells are connected through plasma with the endodermis, which makes transport to the endodermis possible.

Passive uptake

In the roots also passive uptake of elements take place, which does not need energy. On the surface of the membrane there are negatively charged areas. Cations (positively charged ions) are adsorbed here. The inside of the membrane is mostly more negatively charged than the outside. As a result, cations are drawn in, even though this transport is directed against a concentration difference. This passive uptake is not significant for anions (negative charged ions).

Transport of water and nutrients trough the plant

Once ions have passed through the cell membrane of the root cells and arrived in the cell plasma, then they move from cell to cell via the plasma where they can not be hindered by the Casparian strip and can pass the endodermis to end up in the xylem vessels. From there they are transported, either through root pressure, or through the transpiration flow. Nutrient elements are first transported to the transpiring parts of the plant, the leaves (where the xylem vessels are present and the under pressure is greatest). From the leaves the nutrient elements can then be distributed further. Through the phloem the nutrient elements and the assimilates produced by the leaves, are transported to plant parts with little or no transpiration, such as growth tips, buds and root tips. However, not all elements end up in the phloem. Calcium and boron for example, after they have reached the leaves with the xylem vessel flow, are fixed and cannot be transported further, or only to a very limited extent. Therefore the growth tips are completely dependent on root pressure for calcium supply. As a result of root pressure, transport takes place not only to the leaves,

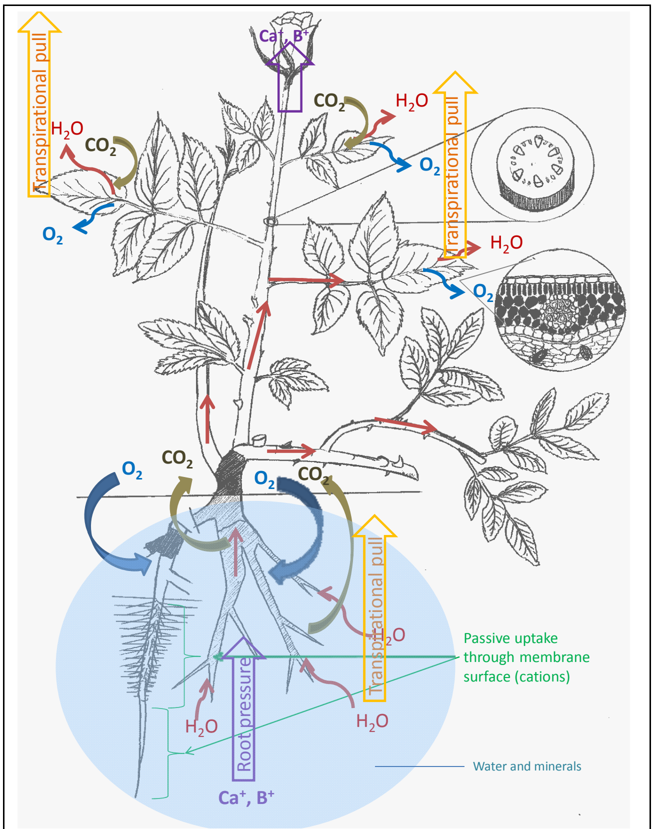


Figure 7.3: Transport of water and nutrients through the plant

but also to the plant parts without transpiration. The plant parts that have little transpiration therefore always have low contents of these elements, for example the young shoots and the rose bud.

Transpiration and mineral management
It has been explained that water transport and distribution of part of the minerals are closely connected to one another. For optimum nutrition therefore a well-balanced nutrient solution is required, but certainly also a good climate control. Excessive transpiration may lead to accumulation of minerals in the transpiring leaf and deficiencies in the growth tips. Insufficient transpiration also causes problems because then insufficient supply of certain minerals to the leaves takes place

7.2.2 Fertilization

A fertilizer is a substance added to the soil or substrate where the roots are anchored to improve plants' growth and yield. In intensive horticulture, the most common way of fertilization is by means of a nutrient solution, applied through the irrigation system.

Nutrient solutions
A nutrient solution is a solution containing all nutrient elements necessary for the plant in optimum concentrations and proportions. For many important crops, as for rose, and also for different substrates, so-called standard nutrient solutions have been composed through research and experience. These are composed in such a way that the sum of cations and anions of the main elements are equal in equivalents. This makes calculation of a fertilizer recipe with the available fertilizers a difficult task.
In substrate crops the rooted volume and consequently also the amount of nutrients available to the plants is limited in comparison to the situation in the soil. To avoid exhaustion the plants should be frequently provided with nutrients. Detailed experiments show that frequent application of water and nutrients is needed to realize a stable supply of water and nutrients, and a uniform distribution of water and nutrients in the soil or substrate. The more stable and uniform the supply and distribution of water and nutrients, the better the effect on crop growth. Shortages may rapidly occur particularly of nutrient elements that are taken up by the plants in considerable quantities, such as potassium and nitrogen. Apart from a few exceptions, substrates other than soil do not contain nutrient elements, and thus all necessary nutrients must be provided to the crop. It is important that the supply of nutrient elements is adjusted to the requirement of the crop. This requirement is not only based on the absolute uptake of an element, but also the mutual relations of elements in the root environment necessary to realise optimum contents of nutrient elements in the plant. Since there is great difference in ‘uptake rate’ between elements, the proportions between nutrient elements realised in the root environment are different from those at uptake. Due to unbalanced application certain elements may accumulate strongly. To avoid such problems, ion-specific nutrient application technology is being developed. The philosophy is to apply nutrient amounts that have just been taken up by the crop.
Higher concentrations are needed near the root of ions that are taken up with more difficulty, such as Ca, Mg and Fe. Other ions, such as NH_4 and B, which are taken up quickly, require a much lower concentration in the root environment.
Depending on a number of situations adjustments are needed for the growth phase of the plants. In addition adjustments are carried out on the basis of analytical results of samples from the root environment.

7.3 Practical implementation

Fertigation is the technique of supplying dissolved fertilisers to the crop through an irrigation system. When combined with an efficient irrigation system both nutriens and water can be manipulated and managed to obtain the maximum possible yield of marketable productions. Not only managing the required quantities of water and nutrients applied is important. Water quality, ratios, sources of elements and fertilizer quality are just as important.

7.3.1 Water quality

Water quality properties include physical, biological and chemical properties. Physical water properties include the presence of suspended solids and temperature. Suspended solids (e.g. soil particles) are potential problems, as they can clog the irrigation system and drip lines and cause damage to irrigation equipment

Biological water properties include algae, microbes and diseases. Algae and microbes are concerned a problem, as they may cause clogging of the irrigation system and attract certain fungi that can damage the plant roots. Especially in water reservoirs algae can cause a problem and need to be controlled. This can be done simply by covering the reservoir (no sunlight, so the development of algae is reduced) or by applying cupper sulphate (CuSO4, 40gr per 100 m^3 of water) to the reservoir water (), which suppresses the development of algae. Diseases can of course damage the crop and thus infection should be prevented.

Chemical properties are obviously given main focus when dealing with irrigation water and include parameters like pH, EC, alkalinity, hardness and nutrient composition (soluble salts, specific ions). Although pH and alkalinity are often used as interchangeable concepts, these are two totally different parameters. While pH is an actual measure of water acidity (measured by hydrogen ion concentration), alkalinity is a relative measurement of the capacity of water to resist a change in pH or the ability of water to change the pH of the growing media (i.e. buffering capacity of water). Hardness of water refers to combined concentration of Ca and Mg and can be used as an indicator ok alkalinity. Hard water (high Ca and Mg concentrations) is a potential problem, as calcium and magnesium can combine with bicarbonate to form insoluble salts. These salts can influence pH and reduce the amount of sodium available to the plant. Source water and drain water analysis should be repeated at least every three months to get sufficient insight in the water condition and to make adjustments to the fertilization regime (see section 4.3.1. and Annex 6).

7.3.2 pH

The pH is a measure of the acidity or basicity of a solution. Pure water is neutral, with a pH close to 7.0 (at room temperature, 25 °C). Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic or alkaline. The pH range is between 0 and 14. The pH determines, among others, the absorption of nutrients by the plant. The optimum pH level for a rose plant lies between 5.5 and 6.5 (soil 5.8 – 6.8, hydroponic drain 6.2 – 6.4). At this level, all the elements are sufficiently available to the plant in proper proportions (see figure 7.4).

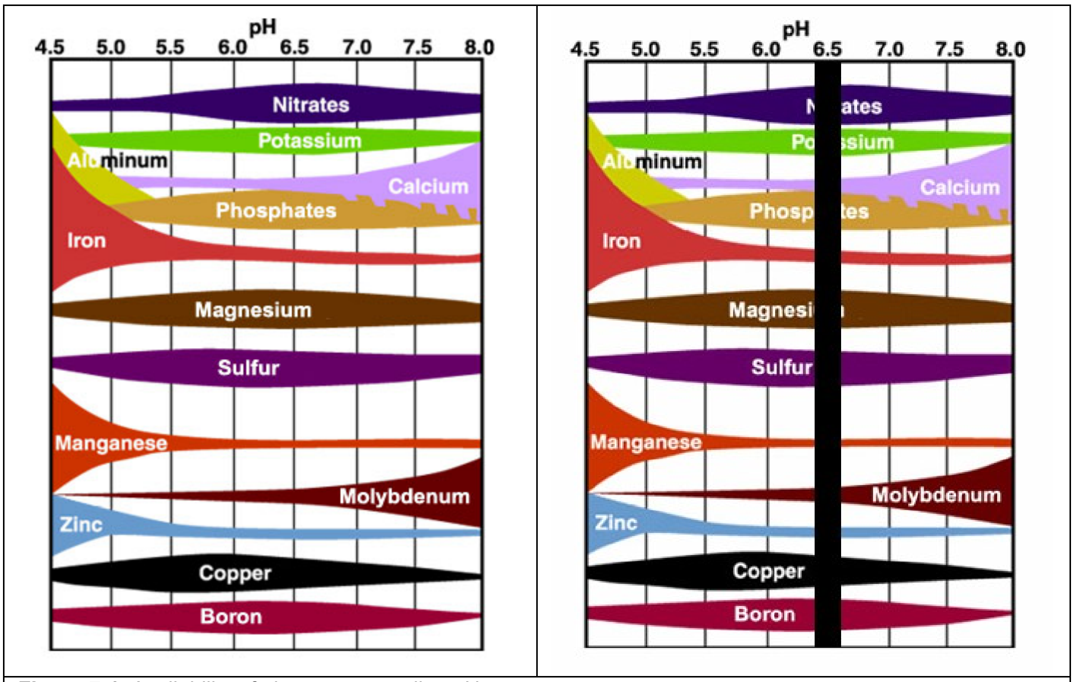


Figure 7.4: Availability of elements according pH

The pH level can be measured in two ways: with an electronic device and with indicator paper. Electronic pH sensors (see figure 7.5) are expensive and need to be calibrated every two weeks, but are also very accurate. A more low-priced method of pH measuring can be done with indicator papers (see figure 7.7). The papers are dipped in the solution and need to dry before interpreted (about 10 secondes). The color of the paper is compared to a color scheme to measure the pH level. This takes more time and is much less accurate than with an electronic device (however, depends also on the brand you are using).

Figure 7.5: Digital electronic pH sensor

Figure 7.6: Calibration liquid pH 4.01 and 7.01

Figure 7.7: pH indicator paper

7.3.3 Electric Conductivity

Electric conductivity (EC, µS/cm) is a measure that indicates the amount of total dissolved salts or ions in the water. Adding fertilizers to a solution increases the EC (see Annex 12), i.e. the lower the EC, the fewer nutrients the water contains.

For a rose plant the EC is very important and should be kept at an optimum level to ensure optimal production. The optimal EC depends on the growing season and type of cultivation system (soil based or hydroponic). A high EC level causes lower uptake of water, closing of stomata and less growth. However, stems will be stronger and leaves colored darker, as the percentage of dry matter increases. During the rainy season, when the crop is more sensitive to diseases, firm leaves are desired and thus higher EC levels are required to achieve this. During normal growth a lower EC level can be maintained, to ensure easy water uptake and higher production. In table 7.1 indications for optimal EC levels are given.

Table 7.1: Optimal EC levels

Hydroponic	Season		Soil	Season	
	Dry (µS/cm)	Rain (µS/cm)		Dry (µS/cm)	Rain (µS/cm)
Drip water	1.4 - 1.6	1.6 - 1.9	Drip water	1.0 - 1.4	1.4 - 1.7
Drain water	1.6 - 1.8	1.9 - 2.1	Soil	0.6 - 0.7	0.7 - 0.9

Soil based systems have higher buffer capacities than hydroponic systems; clay soils have higher buffer capacities of water and nutrients than sandy or loam soils. Hydroponic systems need to be managed more precise, because of the lower buffer capacity. Therefore it is important to regularly measure the EC level of the drip, drainage and irrigation water

The EC level can be measured with EC meters (see figure 7.8). Make sure that you check the EC level at the fertigation unit and at the water that flows out of the dripping system. The meters have to be calibrated every two weeks with calibration liquid.

Figure 7.8: Digital electronic EC sensor (solution)

Figure 7.9: Calibration solution EC

Figure 7.10: Digital electronic EC sensor (soil)

The EC level of the soil should also be measured. The best way to do that is to use a special meter as shown in figure 7.10. If you only have a normal EC meter for solutions, the 1:2:2 extract method can be used to measure the EC of the soil (see Annex 13).

Tip!
Make sure you check the EC level in water and soil on a weekly base on the same day at the same time. In this way you can compare the results and see if the EC level is increasing, decreasing or remains the same and take action accordingly.

7.3.4 Nutrient elements

In general a rose consists for about 75% of water. The rest is so-called dry matter and the content varies per variety and per plant part (stem, leaf). The largest part of the dry matter consists of organic compounds such as sugars, starch and cellulose, which are synthesized by the plant by means of the photosynthesis process. About 10% of the dry matter consists of inorganic compounds, mostly nutrient elements (minerals). The inorganic compounds are taken up by the plant from the soil or nutrient solution.

The nutrients are categorized as major elements (macro elements) and trace elements (micro elements) (see table 7.2). Macro elements are present in the plant in high amounts and uptake by the plant is high. Micro elements are important, but are taken up by the plant in small amounts. Both the macro and micro elements are essential for plant growth. If one of these elements is present in insufficient quantities, deficiency symptoms are observed. Frequently, however, growth inhibition occurs before deficiency symptoms are visible. Annex 14 explains in more detail the role of the macro and micro elements for the plant.

Table 7.2: Macro and micro elements

Macro elements	Symbol	Micro elements	Symbol
Nitrogen	N	Iron	Fe
Potassium	K	Manganese	Mn
Phosphorus	P	Copper	Cu
Magnesium	Mg	Zinc	Zn
Calcium	Ca	Boron	B
Sulphur	S	Molybdenum	Mo
Silicon	Si		

In addition to the elements mentioned in table 7.2, also other elements can be found in the analysis of plant material, which have been absorbed by the plant. This, however, does not mean to say that they are essential for the plant to function. Sodium (Na) and chlorine (Cl), for example, are almost always found. The role of these elements is, however, limited and the necessary quantities are at the level of trace elements.

7.3.5 Synergism and antagonism between elements

Synergism implies that elements can interact in ways that enhance each others effect. Antagonism is exactly the opposite and implies that elements counteract or unwanted chemical reactions occur. With preparing the fertigation solution, the synergistic and antagonistic interactions between the elements should be taken into account. Calcium has got the most antagonists; Molybdenum has the most synergists. In figure 7.11 and table 7.3 all elements with synergist and antagonists are shown.

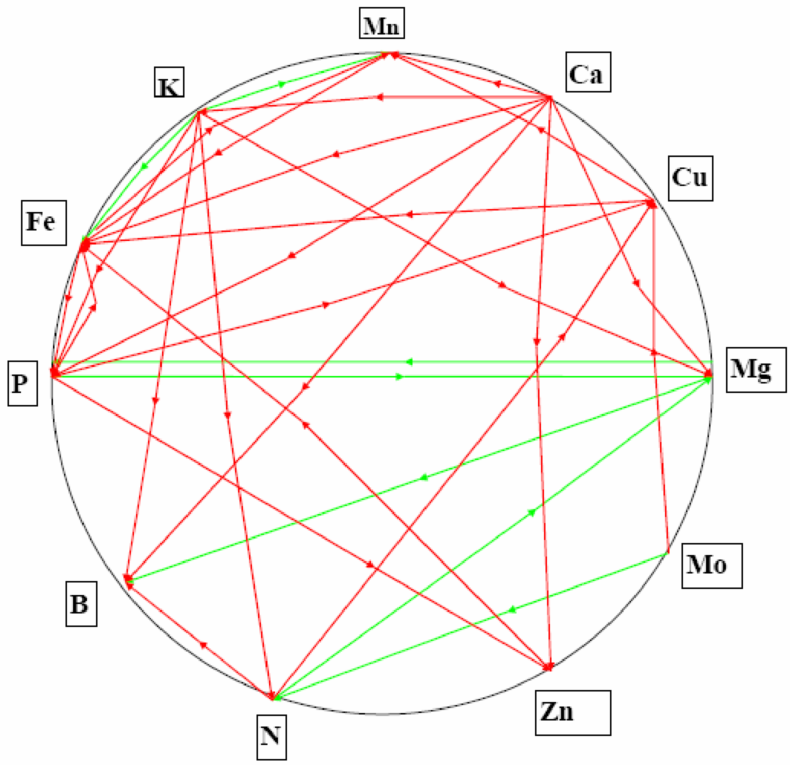


Figure 7.11: Synergism and antagonism between elements

Table 7.3: Synergism and antagonism between elements

Element	Symbol	Antagonist	Synergist
Manganese	Mn	Mg, Cu, Fe	K
Zinc	Zn	Ca, Cu, P, Fe	
Iron	Fe	Ca, K, N	K, Mo
Boron	B	Zn, Ca, Cu, K	Mo
Phosphor	P	Fe, Zn, Ca, Cu, K	Mg, Mo
Nitrogen	N	B, Cu	Mo
Ammonium	NH_4^+	Ca, K	
Nitrate	NO_3^-		Mg
Potassium	K	P,B, Ca, Mg, NH_4^+, K, Cu, Mg	Mo
Cupper	Cu	N, P, Fe, Zn, Mn, Ca, Mo	
Molybdenum	Mo	Cu	Fe, B, P, N, Ca
Magnesium	Mg	K, Mn, Ca	NO_3^-, P
Calcium	Ca	Zn, Fe, B, P, NH_4^+, K, Cu, Mg	

7.3.6 Feeding recipe

Composing a feeding recipe is not an easy task and requires specific knowledge (see also section 4.3.2. and Annex 6). The results of the soil and water analyses provide the input to compose or adjust a feeding proposal and should be repeated regularly to provide up to data information. The right feeding recipe is influenced by many factors, e.g. the weather, the season, the growing stage of your crop. In the rainy season the ratio of Potassium, Calcium and Magnesium are different than in the summer. During the rainy season the crop is more sensitive to diseases and thus the Calcium ratio should be higher to create stronger and less vulnerable leaves (summer K / C / Mg: 5 / 5 /3; rainy K / C / Mg: 4 / 6 / 3).

7.3.7 Fertigation system

An advanced fertigation system should be able to regulate total amount of fertilizer applied, proportion of fertilizers in the irrigation water, duration of applications, and start and finishing time. For application of fertilzers three different techniques can be used:

- Continous application: Fertilizer is applied at a constant rate from irrigation start to finish. The amount of fertilizer is injected, regardless of the water discharge rate
- Three-stage application: Irrigation starts without fertilizers. The injection begins when the ground is wet. Injection stops before the irrigation cycle is completed. This allows the fertilizer to be flushed out of the system with the remainder of the irrigation.
- Proportional application: The injection rate is proportional to the water discharge rate (e.g. on liter of solution to 1000 liters of irrigation water).

There are two different kinds of fertigation systems that work in Ethiopia and a lot of different brands to choose from. It is important to consider the practical implementation of the system. Ask yourself for example if sufficient spare parts are available and if they can be delivered in a timely manner.
The first system is an inline system (direct injection). With this system use is made of separate tanks alongside the system. Two different tanks and an acid tank to control the pH is enough. The dissolved fertilizers from the separate tanks are injected into the mixing chambers, where they are mixed with irrigation water. The highly concentrated solution in the mixing chamber will be injected directly into the main line. The system is equipped with a dual EC and pH sensor to measure the nutrient solution and the mix to suit the desired EC and pH values (see figure 7.12).
The second system is similar to the first system. The difference is that it doesn't inject a highly concentrated solution in the main water line but mixes it in a separate tank, which makes the control on mixing of A-tank, B-tank, acid tank and pH and EC much more accurate (see figure 7.13).

Figure 7.12: System for direct mixing in a small chamber and direct injection into the main water line.

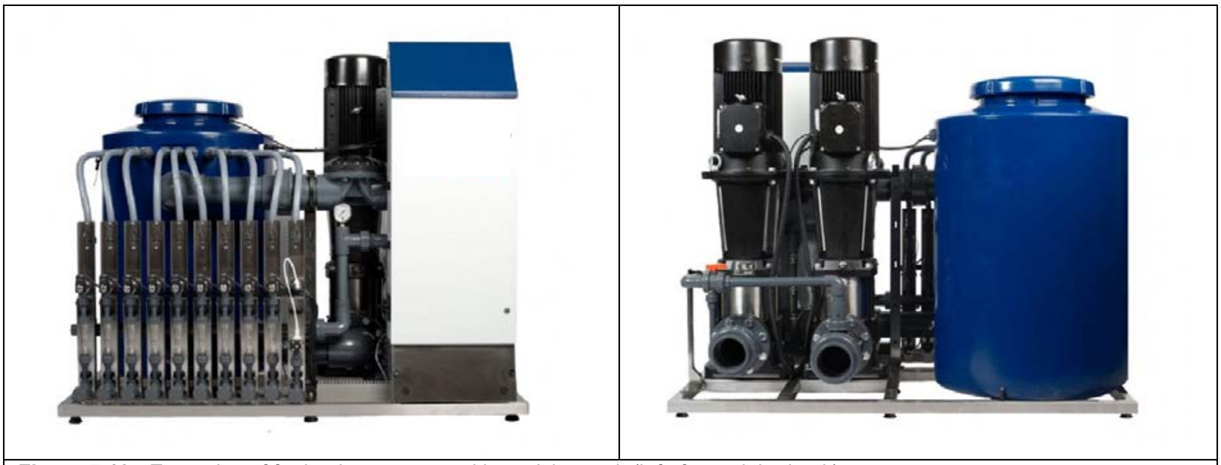


Figure 7.13: Examples of fertigation systems with a mixing tank (left: front; right: back)

At the fertigation unit you will use two different tanks, tank A and B. Besides these two tanks you also need a tank with an acid supply to reach the right pH value in the dripping water system. The reason to have more than one tank for fertigation is that some fertilizers do not mix. It is impossible to have Calcium (Ca) with Sulfate (SO_4) and Phosphate (P) fertilizers in the same tank, for example. In this case the combination will form gypsum that will eventually block the water line, sub lines and/or drip lines.

Tank A & Tank B

Tank A should contain Calcium, such as Calcium chloride (CaCl) or Calcium nitrate ($CaNO_3$) and chelated Iron. The pH value of tank A should be approximately 5.5. A too low pH will damage the chelated form of the iron. It is important to cover tank A and protect it from (sun) light because it will affect the solution.

Tank B should hold Sulphate and Phosphate fertilizers plus all microelements. The pH value of the tank should be between 3.5 and 4.5.

Table 7.4: Fertilizer tanks

Tank A	Tank B
Calcium fertilizers like CaCl, $CaNO_3$ Iron and other chelated micro nutrients pH around 5.5	Sulphate and Phosphate fertilizers All the unchelated micro nutrients pH between 3.5 and 4.5 not higher than 4.8

Filling of the tanks

Make sure you measure the right amount of fertilizers, which will be both liquid and solid. Fill up the tank with water for about 60%. Add the fertilizers. Start with the highest and end with the lowest amount of required fertilizer. Mix the solution and add water until the tank is filled maximally. Make sure to finish tank A before moving on to tank B. Do not fill the tanks at the same time in order to avoid unnecessary mistakes. Never mix Calcium with Sulphate or Phosphate fertilizers.

Maintenance

It is necessary to do regular maintenance work at the fertilization system to ensure optimal fertilization and prevent failures. Besides cleaning the fertilization unit and the surrounding area from dust and water, it is also important to clean the filters. The entire system must be checked regularly for leaks and air bubbles in pipes and the pump pressure should be monitored as well. The filters and dirt traps should be cleaned once a month, which can be done by rinsing it out with water. The EC sensor and pH sensor need to be calibrated and cleaned once a year. It is advisable to draw up an annual maintenance procedure. Check the manual of the fertigation unit for more details on the actual maintenance requirements.

7.3.8 Irrigation system

In general there should be several water sources available to be used for rose cultivation on the farm. A nearby lake or river can be used as an irrigation source, or a borehole. But also make sure to have a water reservoir on site to store water and / or capture rain water. The quality of water sources can vary heavily per region. It is therefore important not only to locate possible water sources around your rose farm but also to investigate and determine the water quality.

Figure 7.14: Drop line in an Ethiopian greenhouse

The irrigation system in the greenhouse consists of a basic system, consisting of a pomp to circulate the irrigation water, mostly a water filtering system to clean the water, main lines to distribute the water inside the greenhouse and a drip or drop line to provide water to the individual plants (which are put on top of the beds).

7.4 Business case: Learn from your mistakes – The case of expired calibration fluid

Company : Dugda Floriculture
Location : Debre Zeyt
Production area : 17 ha
Main varieties : Belle Rose, Mariyo, N-Joy, Tenga Venga, Kiwi, Mylo, Kalahari, Blush, Sunray, High Society and Tucan.

Dugda Floriculture is located in the Debre Zeit area. Dugda Floriculture has had experiences from first hand with poorly calibrated fertigation system and equipments. Production manager Bereket Adana explains:

“Fertigation is very important when cultivating roses. It all starts with a good working fertigation system. The system’s EC en pH sensors and the handheld portable sensors need to be calibrated on a regular basis to ensure that the right values are measured and can be used for applying fertilizers and water. Some time ago we found out that the calibration liquid we were using was expired. So the fertigation unit and the handheld portable devices were incorrectly calibrated. Therefore, the values of the drip and drain pH were actually much higher then we thought they were. If you discover such a problem too late, this can cost you a lot of production and can cause damage to the crop. Through this experience we have learned that good equipment, and above all well calibrated equipment, is essential. We have learned from our mistake and from now on we make sure that we always have an adequate stock of up to date calibration fluid.”

8 Crop protection

8.1 Introduction

Crop protection is an important part of crop production and plays a key role in safeguarding crop productivity against competition from pests and diseases. It determines for a large part your actual production level, with yield-proctection measures to limit the impact of reducing factors of pests and diseases (see figure 8.1). Crop protection includes all management actions that keep the crop strong and healthy, free from pests and diseases. If plants suffer from pests or diseases, reduction of yield and product quality can be substantial, so crop protection should have highest priority.

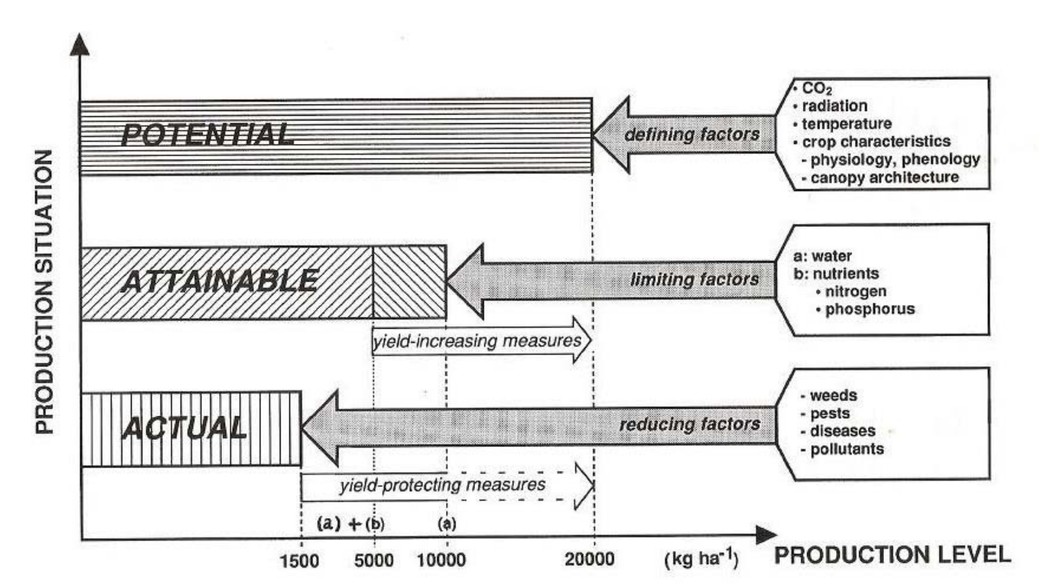


Figure 8.1: Potential, attainable and actual production

8.2 Theoretic background

8.2.1 Pests and diseases in Ethiopia

The major pests and diseases that occur in Ethiopian rose horticulture are summarized in table 8.1, which is based upon a survey held with a representative number of rose growers in Ethiopia in 2006. Spider mite and powdery mildew were most common the dry season; downy mildew and botrytis in the wet season.

Table 8.1: Seasons in which pests and diseases appear according to the growers. A total of 25 rose farms were interviewed. (Source: den Belder & Elings, 2007)

Season	Red spider mite	Two-spotted spider mite	Thrips	Downy mildew	Powdery mildew	Botrytis	Cater-pillars	Aphids	Back spot	Agro-bacterium	Cut worm
Dry	24	1	6		23		1	2			
Wet				25		22	2		1		
Dry & wet	1	1	3		1		2	6	1	3	1

At present, additional to the pests and diseases mentioned in table 8.1, the pests white fly, mealy bug and nematodes are also problems that occur in Ethiopian rose production. In Annex 15 the pests and diseases are discussed and explained in more detail.

8.2.2 Preventive and curative measures

Crop protection includes a wide range of preventive and curative measures. Examples of preventive measures are: growing a strong crop, use of resistant or tolerant varieties, humidity control, insect nets in ventilation windows, the use of sulphur evaporators, soil disinfection, and good sanitation. Examples of curative measures are: spraying chemicals, release of predators, and removal of infected plants. Preventive measures are better than curative measures, certainly for diseases for which no curative remedy is known (for instance, Agrobacterium). Good pest and disease management starts with growing a strong crop, as a strong crop possesses a greater resistance. In this way, pest and disease management is closely associated with irrigation, fertilization, climate control, bush management, and other aspects of crop management.

8.2.3 Chemical pest and disease management

Pests and diseases must be kept at a minimum level. Some infection is often acceptable, as low infection does not always result in reduction of yield or product quality. Furthermore, a 'zero-tolerance' approach is very expensive and may result in resistance build-up by the pest or disease against the chemical. So, a distinction must be made between the action threshold and the damage threshold. Curative crop protection action must be taken when the appropriate measure is still effective and results in continued low infection levels. If the grower acts too late, then more chemicals might have to be sprayed. Only if the infestation level keeps increasing, damage may occur. For example it may not be possible to reach 0% infection, or only at high costs. And if some insect eats away 5% of the leaves, production will not noticeably suffer. But at 10% consumption of leaves, it may lead to yield reduction. In this example, 5% is the action threshold, and 10% the damage threshold.
The action threshold depends on many things. For example on the applied type of chemical, as these may vary in their effectiveness. Biological control is best started at planting, to allow for a build-up of the predator population.

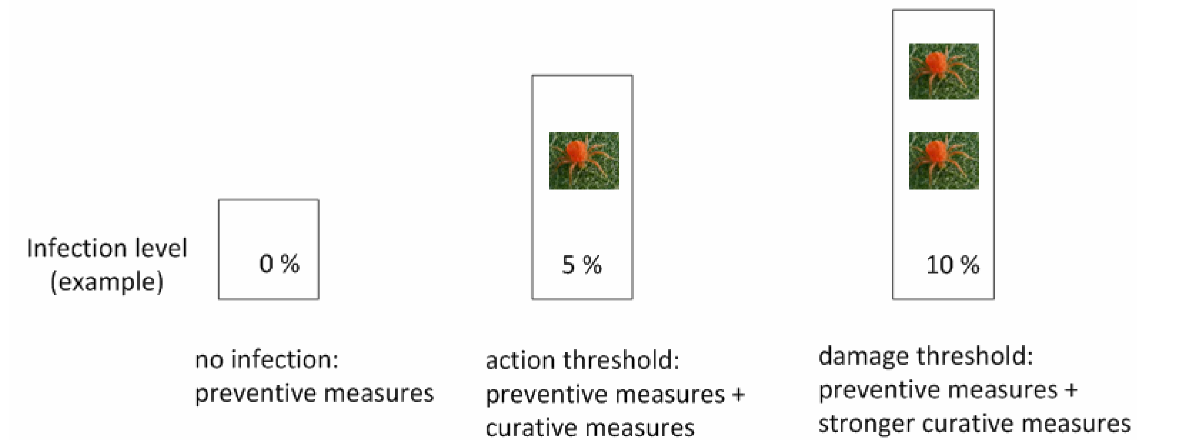


Figure 8.2: Preventive measures are always needed. Curative measures are needed at the action threshold

The management of diseases heavily depends on sanitation: destruction of old crops, removal of weeds, removal of plants with disease symptoms, use of disease free planting material and resistant varieties, use of clean water and disinfectants.

8.2.4 Towards Integrated Pest Management

Integrated Pest Management (IPM) is a method to control pests and diseases in an environmentally responsible matter, by integrating various methods of control in order to reduce or minimize the use of pesticides. With IPM, chemicals should only be applied (curative and spot spraying) when no other methods will work. In greenhouses, chemical spraying is strongly reduced and biological control agents (BCA's) are introduced. A biological equilibrium develops between the pest and the BCA. Of both, low numbers are present in the crop, without harming production. IPM has a number of advantages over chemical pest management. To name a few: reduction in chemical costs, labour conditions improve because spraying is much less needed, there is not a no-entry time to the crop and other activities can therefore continue, there is less build-up of resistance to chemicals in the pest

population, product quality and quantity can increase because chemicals may also harm the crop itself and IPM in Ethiopia contributes to the code of conduct and certification schemes.
It is possible to protect your crop against pest and diseases through calendar spraying. In this case, on a particular day, just because it is for instance Monday, the crop is sprayed with a variety of chemicals against possible pests and diseases. The occurrence of the pest is not checked. The first step forward is to apply chemicals on the basis of observations, and to actively decide that spraying is needed because the number of pest insects is increasing. IPM is one step further: pest management decisions are made on the basis of observations. The success of IPM depends on a good understanding of the crop, the pest, the climate and the control measures. Knowledge, training, continued learning, an open attitude and frequent discussion are all very important. Even though the technology may seem simple (release of bottles with predators), the science behind is complex. Communication between scout and crop protection manager must be frequent and open.

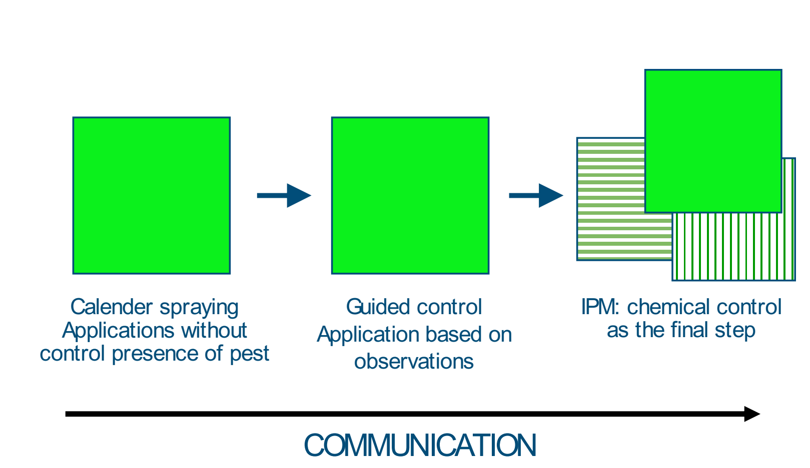


Figure 8.3: Envisaged steps forward in Ethiopian IPM. (Source: den Belder & Elings, 2007)

8.2.5 Pest and disease management

Pest and disease management knows three distinguishable phases:

1. Know what you have
   a. Pests (and predators) are sampled and determined for the correct species.
2. Know how much you have
   a. Collection of raw data, walk-through careful inspections, the regular scouting, the checking of monitoring devices (e.g. sticky yellow traps).
   b. The raw data are arranged in a pre-described format (which in itself requires some thinking) with appropriate columns, averages, greenhouse maps, etc.
   c. The organized data are further processed and linked with other information, such as the climate or moments of predator introduction. In this step, causal relations are developed, which form the basis for an informed pest management decision.
   d. The full information set is interpreted in such a way that various options for pest management can be developed. For instance: more or less frequent introductions of BCA's, an emergency spray with soft chemical product.
3. Know what to do
   a. The management options are balanced, and eventually a decision is taken.
   b. Finally, the best management option is implemented.

Various actors play a role in this process. From the beginning to the end, the involvement moves from the scout to the farm manager. This of course has implications for training needs. The following actors at the farm play a role:

Scouts

Scouts collect information with regards to the presence of pests and predators, and provide the information to the crop protection manager. The scouts need to have an intimate knowledge of pest and predator species, and need sufficient understanding of population dynamics and pest management to be pro-active and flexible. It is essential that the field scout is competent, dependable, and is committed to perform the job over a number of growing seasons to become an effective and experienced field biologist. Although a field scout may function under the supervision of an experienced farm manager, it is important to recognize that significant decisions will be based on the

field scout's observations. As a result, the success or failure of a pest management programme depends on the performance of the field scout. Experiences show that the programmes that have remained effective over time have had one key ingredient, namely the continuity of experienced field scouts. The factor most responsible for terminating field scouting programs is the repeated employment of inexperienced field scouts to service growers.
The tasks of the field scout include:

1. Making accurate identifications of pests and related crop injury present in the field
2. Determining the abundance of the pest populations and degree of injury present
3. Noting relevant parameters related to crop development
4. Recording all field observations in manner that can be forwarded to the party making the final decisions regarding pest management actions to be taken. Such a task applied to one or more crop production systems requires mastering a significant amount of knowledge in agricultural biology and sampling methods.

Crop protection manager
The crop protection manager receives scouting data from the scouts and decides upon actions to be taken. The crop protection manager therefore needs to be aware of action thresholds. The crop protection manager is fully aware of all aspects of IPM and other pest management techniques, details of chemicals, etc. Good communication skills with the scouts and the farm manager are required.

Farm manager
In the Ethiopian context, the crop protection and the farm manager work closely together. The farm manager places crop protection in the broader context of farm management.

Farm owner
The farm owner needs to support the implementation of IPM. Often, the support is based on the desire of a more effective pest management strategy, proven production increase, and the desire to adhere to the code of conduct. The farm owner is not involved with day-to-day issues.

8.3 Practical implementation

8.3.1 Scouting for pests and diseases

Scouting is an essential component of crop protection and should be done on a regular basis to identify in time the presence of pests and diseases in the greenhouse, before serious damage occurs. Early discovery of pests and diseases will substantially minimize production and quality loss, and reduce crop protection costs and environmental impact.
Scouting procedures should be performed as routinely as any other crop management task and should be done at least weekly. Scouting should follow the same pattern every time and sampling methods should be standardized, so comparison can be made from week to week. Growing areas are mostly too large to be sampled as a single unit. Therefore the greenhouse should be divided in more manageable units (e.g. greenhouse bays). Maps should be made of the greenhouse, for recording and registration purposes, detailed to the level of manageable units, bays and beds. For each manageable unit one scouting form should be used (See Annex 8)
Scouts walk every aisle and move slowly from bed to bed in a fixed pattern, to inspect the plants. Scouting can also be done by employees that harvest the roses, but best is to have a special scout team. Of course, employees that harvest the roses should always keep an eye out for any signs of pest and diseases during harvesting.
During scouting several plants per bed should be inspected thoroughly, i.e. about 10 plants per row and 3 leafs per plant. Inspection of a single plant starts at the bottom of the plant, proceeding upwards, looking at older leaves, younger leaves, new growth and undersides of leaves. When infections are found, it should be recorded on a scouting form what kind of pest / disease is found in what location (bay, bed and location in bed) and to what extent (low, medium or high). Thresholds for the levels of infestations should be decided on and are crop, variety, location, season, crop development stage and climate dependant. The plant or location has to be tagged or marked (e.g. with

flagging tape, see figure 8.4). Each pest / disease should have its own colour code for marking, so it is easy to see for the spraying team what pests are located where in the greenhouse.
Additionally indirect monitoring can be done by placing sticky cards / traps just above the crop canopy (about 10 sticky plates per row). Blue cards are mainly used for thrips, yellow cards for white fly, and winged aphids (see figure 8.5). Additional cards can be placed near doors or vents. Sticky cards should be examined and recorded during routine scouting. Threshold levels of number of insects per surface unit of a sticky card can give a quick indication of low, medium or high infestation.

Figure 8.4: Marking infection during scouting

Figure 8.5: Sticky plates

Each week the scouts, crop protection manager and production manager should review the scouting information and decide on appropriate actions to take: choice of chemical, rate of application, method of application (full greenhouse, site or spot application), scheme on any required repeat of treatment (how many repetitions, at what interval). Every pest and disease control action should be recorded and scouts should monitor and record the effect of the action taken (after about 3 days). If the effect of the control action has not been sufficient, it can be decided to take additional measures. At the end of a growing season, production manager and scouts can examine the records to identify certain trends in pests and disease populations.

8.3.2 Spraying

Spraying activities in the greenhouse can be based on scouting records (curative spraying) or recurring schedules (preventive spraying). Depending on the type, extent and intensity of the pest or disease infestation, a choice can made between different spray systems that all have their own benefits and disadvantages.

Central spraying

The most common spraying system is a central spraying unit that is located outside the greenhouse. The unit is connected to the greenhouse with pipes and a pump (see figure 8.6). Spraying is done through a system of hose reels with a lance or a trolley system. The system is solid: because the tank and pump are kept in one place and do not move around you will not often be confronted with broken parts. However, the system needs often and thorough cleaning (flushing the lines after spraying with clean water) and it is hard to monitor how much chemicals have been used per bay.

Figure 8.6: Central spraying system connection point

Local spraying

Another option is a system for localized spraying with a backpack pump (see fig. 8.6). Employees can build up pressure on the pump manually (20-25 bar) and spray the rose beds from a small portable tank. The backpack pump is especially useful when you want to spray locally in parts of the greenhouse. Or if you want to give the biological predators some extra support because the population of harmful pests is too high.

The following guidelines will help you prepare the spray tank before spraying:

- Check if there are deficiencies in the pump, tank and power supply
- Fill the spray tank with water for 25% of the spraying amount
- Turn the pump on and let the water circulate in the spray tank
- If two chemicals are applied in the tank, put them separately in the tank
- Fill up the tank with water
- Check if the pH is 5.0
- Possible adjust acidification up to 5.0 with nitric acid
- Check the pH level in every tank mix
- Calibrate the pH meter every week
- Add a small amount of red iron to add some color to the liquid
- When working with a white substance, there’s no need to add any red iron
- Place the pump at the desired pressure
- Check the spray gun or lance
- Rinse the hose reel
- Check with a measuring cup if the color (red / brown) becomes visible
- Start spraying

After spraying:

- If the tank is empty, clean the tank with water
- Let the water run off
- Fill the tank with 25 liters of water and flush the hose clean internally until there is no red/ brown discoloration visible anymore.
- Check if defects are created. If so, repair them.

The best times for spraying you crop are 6.00 to 9.30 AM and 3.00 to 6.30 PM. Make sure the crop has been wet for at least two hours, to make sure the chemical is sufficiently absorbed. The maximum temperature in the greenhouse for spraying is 27°C and the minimum temperature is 15°C. The amount of water you use for spraying depends on the crop and Leaf Area Index and the sort of pesticides you deal with, e.g.:

- Pests : +3000 L/ha
- Powdery mildew/downey mildew : 2500-3000 L/ha
- Botrytis : 2000-2500L/ha

In general, always follow the spraying instructions given by the manufacturer on the label of the crop protection chemical container.

Figure 8.7: Spraying

Figure 8.8: Mobile spraying tank

Re-entry time

The re-entry time is the minimum amount of time that must pass between the time a crop protection chemical was applied to an area or crop and the time that people can go into that area without protective clothing and equipment. Different chemical will have different re-entry times. The label on the container of the chemical provides information on the re-entry times.

8.3.3 Drenching / dripping

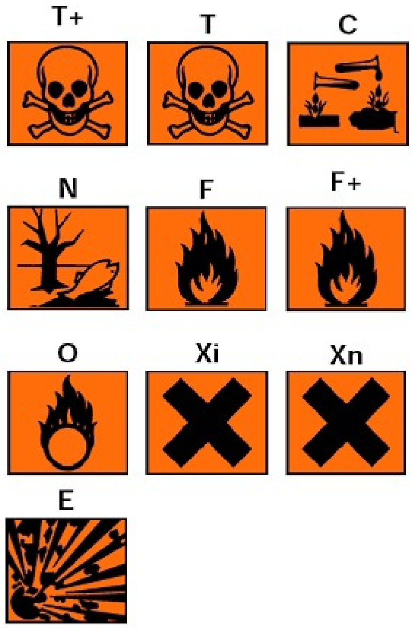
Some chemicals can be applied through the drip lines of the irrigation system. This should be mentioned on the package. Pesticides against nematodes for example typically need to be spread with irrigation water to reach the soil or substrate. The crop will absorb the chemicals better and faster if given through irrigation.

8.3.4 Safety

When working with crop protection chemicals, adequate safety precautions should be followed to protect the health of employees working with them. First of all, make sure that emplyees read and follow instructions and information on the packaging of the chemicals: instructions for use, safety instructions and hazard symbols. Furthermore, protect yourself during handling and using the chemicals by wearing proper protective clothing. Special attention should be given to the use of proper protective masks for the right job. Not only during the actual spraying of the crop, but also during preparation of the spray solution protective clothing should be worn.

Hazard symbols

Packaging of crop protection chemicals provides instructions for use and safety, which are different for each specific chemical. It also displays one or more hazard symbols, which give a quick indication of the dangers that must be taken into account while using the product. In figure 8.7 the most common hazard symbols are shown and explained.



T+	Chemicals that at very low levels cause damage to health
T	Chemicals that at low levels cause damage to health
C	Chemicals that may destroy living tissue on contact
N	Chemicals that may present an immediate or delayed danger to one or more components of the environment
F	Chemicals that may catch fire in contact with air, only need brief contact with an ignition source, have a very low flash point or evolve highly flammable gases in contact with water
F+	Chemicals that have an extremely low flash point and boiling point, and gases that catch fire in contact with air
O	Chemicals that react exothermically with other chemicals
Xi	Chemicals that may cause inflammation to the skin or other mucous membranes
Xn	Chemicals that may cause damage to health
E	Chemicals that explode

Figure 8.9: displays the most common hazard symbols


Figure 8.10: protective clothing symbols


Figure 8.11: Half mask


Figure 8.12: Full mask


Figure 8.13: Dispose mask


Figure 8.14: Protective clothing

Dust Filter & Gas Filter Class

Type	Colour	Description
A		Organic Vapours and Gases with boiling point 65°C and above
B		Inorganic Vapours and Gases (excluding Carbon Dioxide/Monoxide)
E		Sulphur Dioxide and Other Acidic Vapours and Gases
K		Ammonia and Ammonia Derivatives Vapours & Gases
ABEK		Combination filter, all of the above
P	Dust Filter	

Classifications

	Dust	Gas
1	Low Efficiency	Low Capacity
2	Medium Efficiency	Medium Capacity
3	High Efficiency	High Capacity

Figure 8.15: Types of mask filters


Figure 8.16: A2P3 Filter


Figure 8.17: ABEK Filter

Clothing & masks

When working with crop protection chemicals, always wear appropriate protective waterproof and chemical resistant clothing (see figure 8.14):

- Gloves
- Boots
- Overall or coat, pants and hat (chemicals)
- Eye protection / glasses
- Mask

A mask is essential for protection against harmful mist during spraying. You can choose between a half mask (which covers only mouth and nose, see figure 8.11), full mask (which covers the whole face, see figure 8.12) or even a disposable half mask (which can only be used once, see figure 8.13). When choosing a mask, make sure it has a good fit, good seal, double elastic headbands and low breathing resistance. Also, make sure to follow the following instructions when using a mask:

- Use the right filter for the right job (see figure 8.15, 8.16 and 8.17)
- Each mask must have a spare filter
- Clean the mask after each use (inside and outside)
- Check the mask for defects after cleaning
- Place filter caps when stored
- Store the mask in a storing box after use
- Write the hours used on the filter after use

8.3.5 Stock of chemicals and store

Keeping a stock of chemicals at the farm enables you to react promptly to any possible disease or pest (see also section 4.3.6). If you have to order the pesticides when needed it might take from a few days to several weeks before they are delivered to your farm. The damage done to the crop can have a severe impact on production. Furthermore, because you are dealing with chemicals, certain precautionary measures should be taken.

- A repository should be made of fireproof material.
- The floor, walls and barriers need to connect seamlessly to form a liquid container minimum content, the largest container increases by 10% of the remaining packages.
- Close the warehouse with a good lock.
- Clearly post safety instructions.
- Keep pesticides in original containers only.
- Store empty and uncleaned packagings as full containers.
- Keep powders and granules above the liquids.
- Keep sumps under liquid chemicals.
- Keep 6kg of powder near the storage of at least one working fire extinguisher.
- Absorbent granules need to be present in the warehouse.
- Keep water (wash hands) in the immediate vicinity.
- Build a working shower at short distance.
- Keep a first aid kit and appropriate first aid provision close.
- Post an outside sign: ‘pesticides, prohibited unauthorized access'
- Reorganize the chemical stock. Make a difference in Fungal and pests’ chemicals. Make sure all the spider mites chemicals are together.
- Use a digital register for registration of how much and which chemicals are in store.
- Keep heavy and unwieldy packages at low shelves.
- Separate mixing room (not in the store)
- An eye shower should be present in the chemical store an mixing room

Figure 8.18: Well-organized chemical store

8.3.6 Biological control agents

As with chemical pest management, biological pest management is based on careful scouting: identify the species of the pest, and determine the infestation level. Only if this information is available, the right biological control agent (BCA) and the right quantity can be determined. Training in scouting is very important, just as is the interaction with a representative from the BCA supply company.

There is no strict protocol with regards to determination of the infestation level. In some cases, the number of infested leaves on a bay must be counted, in other cases the number of insects. Furthermore, it is important to establish a clear protocol between the grower and the supplier of the BCA, and to provide the BCA supplier every week with the latest counts. It will also be helpful to provide climate data, as for example temperature and humidity influence the development of pests. With this information the biological control experts from the supply company can advise on the best pest management strategy. Discuss openly with the supplier of the BCA what chemicals are used to deal with other pests. These must be 'soft', i.e. not lethal to the BCA. Also be sure that the soil is not contaminated with long-lasting chemicals from past cultivations. Each BCA has its own application method, e.g. small sachet from which the BCA spreads over the crop, or flaxes that are spread over the crop (see figure 8.19) are some common examples.

Figure 8.19: Applying Biological Control Agents to the crop

In rose cultivation in Ethiopia, spider mite is the most important pest that is managed with predatory mites. The main species used are Phytoseiulus persimilis and Amblyseius californicus. For controlling thrips and whitefly the predatory mite Amblyseius swirskii has potential. For a description of these predatory mites see Annex 16.

Growers that are interested in biological agents, best contact the supplier of their preference. Not only biological details will then be discussed, but also arrangements for import permits can be discussed.

8.4 Business case: Integrated Pest Management (IPM) experiences in Ethiopia I

Company : ET Highland Flora
Location : Sebeta
Production area : 12 ha
Main varieties : Valentino

ET Highland Flora is located in the Sebeta area and is owned by Mr Tsegaye Abebe, the Chairman of the Ethiopian Horticulture Producers and Exporters Association (EHPEA). In 2007 ET Highland Flora started as one of the first rose farms in Ethiopia with Integrated Pest Management (IPM). They started with a trial in one of their greenhouses with the variety Valentino, in collaboration with Jimma Univeristy, Koppert and Wageningen UR. Due to positive trial results they decided to apply IPM in all of their greenhouses. Emebet Tesfaye, farm manager at ET Highland Flora, says:

“Before we started to practice IPM, about 60% of the chemical spraying was to control spider mites. With IPM we don’t need to spray for spider mites anymore. Furthermore, even with chemical control it was very difficult to control the spider mites. With IPM the results are much better.”

Emebet was trained by Koppert and Wageningen UR in implementing IPM and visited The Netherlands to see how IPM is applied in practice. Also the scouts of ET Highland were trained in IPM practices. Although IPM needs some initial investments at the introduction (time and money), it will pay off on the long term. Emebet mentions some of the advantages:

“IPM has a lot of advantages. After the trial on our farm we were able to make a good comparison between IPM and conventional chemical pest control for the variety we did the trial for. Some of the benefits we directly observed were: increase in stem length, shinier leaves and bigger leaves. In general the crop looks much healthier. Besides that, the working conditions for the employees are also better.”

Emebet continues:

“Although IPM has a good effect on controlling spider mites, other pests have become more of problem than before, especially in case of trips, aphids and mealy bugs. In principle, every pest can be controlled in a biological way, but it needs to be profitable. Apart from spider mites, the other pests now need to be controlled with selective chemicals, which are chemicals that can be used in combination with IPM. At first, these selective chemicals weren’t available in Ethiopia and had to be imported from The Netherlands or Kenya, which caused problems with availability. The availability of these chemical in Ethiopia has improved since.

Emebet concludes with the remark that she expects that in the future every rose farm in Ethiopia will practice IPM for crop protection.

8.5 Business case: Integrated Pest Management (IPM) experiences in Ethiopia II

Company : Tinaw Business
Location : Wolkite
Production area : 13 ha
Main varieties : Mariyo, Marie Claire, La Belle, Belle Rose, Upper Class, Athena, Blondine, Viva, Heidi

Tinaw Business is located in the Wolkite area (100 km south west of the Sebeta region). Since 2009 they started to practice Integrated Pest Management (IPM). During the first year they applied IPM in a few greenhouses and compared the results with the other greenhouses, where conventional crop proctection was practiced. Production manager Ashok tells about his experiences:

“When we first started to apply IPM, it was difficult because it is a totally different way of crop protection. However, after a while we got the hang of it and it proved to be much easier than conventional crop protection.”

The employees of Tinaw Business were trained in scouting by the biological control agent supplier. However, Ashok mentions that the really experience in IPM was gained by practice by doing. About the benefits of IPM Ashok explains:

“On the long term IPM is less costly as compared to conventional crop protection. As soon as a balance between biological control agents and pest is established, no new control agents need to be purchased. Furthermore, by reproducing control agents on your own farm, the cost price can be reduced. At the moment IPM is most interesting for controlling spider mites. For other pests a cost price calculation should be done to see if it is profitable”

On the response of the crop to IPM Ashok says:

“Both production and quality increased: more stems per m2; bigger and stronger leaves, because of less stress due to chemical spraying; no chemical residues on the leaves and stems, which is preferred by the market; and larger flower bud sizes.”

For the future Ashok expects that all farms in Ethiopia will be using IPM. However, he adds that the government should support and promote IPM and facilitate easy registration and local reproduction of biological control products.

9 Bush management

9.1 Introduction

Bush management of a rose crop comprises of different crop maintenance practices to maintain a strong, healthy and vigorous crop and to build a rose plant that gives the best balance between continuous production, demanded quantity and required quality. Actual bush management actions include bending, cutting, pinching and pruning of the crop. A specific strategy for bush management should best be based on marketing strategy.
In this chapter we discuss the general aspects of bush management, the preparations and activities for planting a new crop, growing strategies and practices when the crop is in production and actual bush management techniques.

9.2 Theoretic background

9.2.1 Plant structure and flower production

The rose plant as we cultivate it for commercial flower harvest is a perennial woody shrub that continuously forms new shoots. Each shoot has the potential to develop a terminal flower bud. After harvesting a flowering shoot, the most distant axillary bud will sprout and develop into shoots. Flower quality declines with increasing plant age and after several years of cultivation (4-7 years), old plants should best be discarded and replaced by new, young plants.
There is a clear relation between plant structure and flower production (see figure 9.1). Investment in plant structure at the beginning of the cropping period is compensated in the subsequent years. Flower production is related to the number and the diameter of the bottom breaks and the first and second order laterals, and by the presence of an optimum leaf package. It is important to select varieties or rootstocks which form more bottom breaks by nature and to stimulate the growth of bottom breaks by means of choosing the right bending, pruning and harvesting methods.

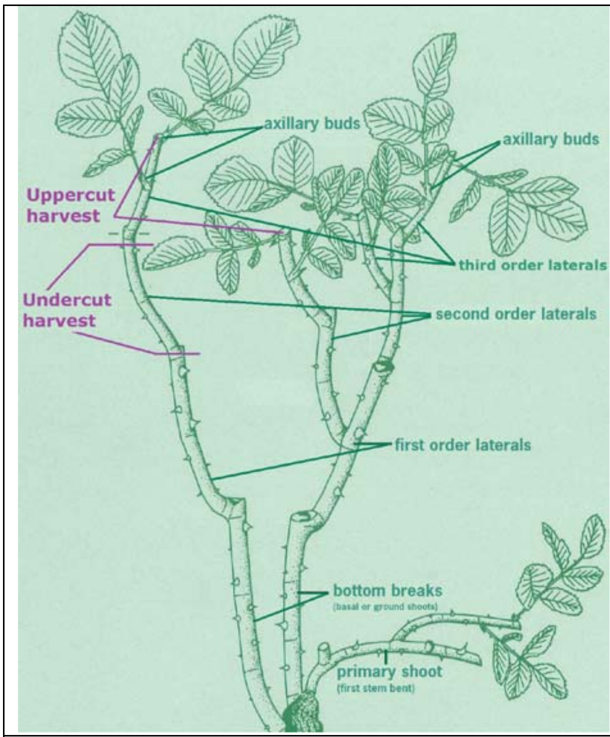


Figure 9.1: Structure of a rose plant

The primary shoot
Young plants for commercial cultivation are propagated vegetatively by several methods, e.g. cuttings, stentlings, different kinds of grafts. Generally, the axillary bud of the scion will develop into a shoot, which is named the 'primary shoot'. The primary shoot flowers normally a few weeks after cutting or grafting. By removing the flower bud as early as possible, one or more of the upper axillary buds will be released from inhibition and start sprouting, forming lateral shoots (also called 'suckers'). Removing the floral buds of these lateral shoots will stimulate in its turn the development of lateral shoots (suckers on the suckers).

Basal shoot, ground shoot or bottom breaks
The natural toppling of the heavily developed primary shoot or the bending (see 'First bend' under 9.3.2), stimulates the sprouting of basal dormant buds (not on a leaf axil). These buds, usually two, develop into strongly growing shoots, called basal shoots, ground shoots or bottom breaks, and are very important while:
- They form (together with their laterals) the frame of a rose plant

- Their number, diameter, and degree of branching determine the potential flower production
- They emerge during the first year after vegetative propagation, after which new basal shoots are rare.

In general there are 6 to 7 potential bottom break buds. The buds are secondary buds present in the bud used for propagation. The number depends on age and position of the bud in the original stem used for propagation. Generally only the lower 2 of the potential bottom break buds develop into actual bottom breaks. If later a third or more bottom breaks develop, they come from the axillary bud of one of the 2 already grown bottom breaks.
Every bottom break is connected to only a certain part of the xylem in the root. The underlying hypothesis is that as soon as a bottom break sprouts the xylem of a root is surrounded by new xylem. This xylem is responsible for the transport of water and nutrients to the new shoot. The new shoot may surround the entire old xylem like a ring. As a result the xylem part directly connected with the primary shoot or first bottom break may be restricted in capacity. In the end this may lead to death of the old shoot.

Factors influencing the number and quality of bottom breaks
Apart from factors like the selection of varieties that form naturally more bottom breaks, the use of rootstocks and applications of the hormone cytokinine (dangerous and not allowed), both environmental (light and temperature) and mechanical actions (such as pinching, lateral bud removal and bending) influence the development of the basal shoots.

Mechanical factors:
- The time for bending the primary shoot is important. When bending is delayed, there are more assimilates available for basal shoot formation; if the primary shoot falls over or is bent too early, the quality of the bottom breaks will be insufficient. To avoid early toppling, you can keep the primary shoot upright by means of a stick. There is an optimal time for bending the primary shoot that depends on the variety: shorter times lead to insufficient quality of the basal shoots; longer times lead to an unnecessary delay of the basal shoot development and consequently, delay in time before harvest. Furthermore, especially for woody cultivars, waiting too long will give a risk of breaking the primary shoot at bending.
- Restricting the number of developing bottom breaks (in varieties that tend to form more than two) for example by breaking them away, positively affects the diameter and the weight of the remaining bottom breaks. The same amount of assimilates is then divided over a smaller number of bottom breaks. The growth rate is not affected.
- Sprouting of the buds on the horizontally bent primary shoot (scion, scion wood) inhibits sprouting of the bottom breaks. Removing the sprouts on the scion wood increases the number and diameter of the bottom breaks. In practice this is never done by growers, because the developed shoots grow additional leaves, which increase the rate of photosynthesis.
- The plant density at early stages of the growth has little effect on the number or diameter of ground shoots per plant. Increasing plant density gives more bottom breaks per m2. The number of bottom breaks per plant, however, does not change. The plant density hardly affects the quality of the developing bottom breaks, because in this stage of growth there is enough room for outgrowth of the shoots.
- New bottom breaks compete with the old ones, which is clearly visible in a reduced diameter and an increased dieback percentage of old bottom breaks. The average stem weight of stems from new bottom breaks is considerably higher than that of stems from old bottom breaks.

Environmental factors:
- Light is important for the sprouting of the buds and consequently for the sprouting of the bottom breaks. More light and light that reaches the place of sprouting directly, promotes outgrowth of the bottom breaks. When the buds are kept in the shadow or when shading is applied they show hardly any development.
- Slightly higher temperature (with light and other factors not limiting) also promotes the sprouting of the bottom breaks.
- Slightly higher relative humidity stimulates the sprouting of bottom breaks.

For this reason at the start of a new cultivation period with young plants, higher temperatures and higher relative humidity are preferred. As soon as the bottom breaks have developed the values are lowered to avoid adverse effects on quality.

First and second order laterals
First order laterals (see figure 9.1) develop in the axile of the remaining leave after harvesting (by uppercut) the ground shoots. Second order laterals develop in their turn in the leave axiles of the first order laterals. The number and diameter of these laterals can greatly explain the differences in number and weight of the flowering shoots in the next cropping years. An optimal number of uniformly spaced, thick laterals should be balanced by a limited stem biomass. Too high stem biomass requires assimilates for maintenance respiration, resulting a reduced net biomass production.

Harvesting and pruning methods not only determine the architecture of a crop, they also have a great effect on yield and quality. An exception is formed by the so-called ‘leaf breaking’ method (figure 9.2). This method has been applied for years to promote outgrowth, especially in winter. By partly removing the leaflet near the bud, no longer hormones are send to the bud at the base of the leaf and consequently it can grow more easily. Leaf breaking can be an effective method for varieties having difficulty with sprouting. Care should be taken not to damage the bud while breaking. Harvest stems as closely above the bud as possible. Leave as little of the wood above the leaf axil as possible. Fungi can penetrate easily through these ‘coathooks’ and, in addition, their presence seems to inhibit the sprouting of the buds.

Figure 9.2: Harvesting methods (from left to right): harvest by undercut, on the first scale, by uppercut (above a 5-leaflet leaf) and partly breaking of the 5-leaflet leave to stimulate outgrowth

9.3 Practical implementation

9.3.1 General bush management aspects

Variety differences
In general two main rose types can be specified: 1) vegetative and 2) woody cultivars. Vegetative cultivars create offshoots easily, are high in production (stems), but are also more sensitive for diseases like powdery mildew, downy mildew and botrytis. Duett is an example of a vegetative cultivar. Woody cultivars grow long and heavy stems, but also produce more blind shoots, are lower in production (stems) and are more problematic for bending. Marie Claire is an example of a woody cultivar.
A second classification that can be made is: 1) large flowering (large size heads), 2) intermediates (medium size heads) and 3) sweethearts (small size heads). Large flowering cultivars are most suitable for highland areas with cool climate conditions to ensure slow growth and good flower quality. However, transport costs are relatively high as compared to those of small flowering roses, especially in the case of intercontinental transport as the only means of transport is by airfreight. Therefore, the majority of the Ethiopian rose farms are located in lowland areas and grow intermediate or small flowering cultivars.

Area of cultivation
As mentioned before, in Ethiopia four principal rose cultivation areas can be specified, based on average altitude and soil type: 1) Ziway (sandy soil, 1650m), 2) Debre Zeit (black clay, 1950m, 3) Sebeta (black cotton soil, 2250m) and 4) Holeta (black cotton soil, 2500m).

In Ethiopia areas with altitudes above 2200m are qualified as highland, areas below 2200m are qualified as lowland. In highland areas the average temperature is lower, so the (phonological) development of roses in these areas is lower as compared to lowland areas. For this reason highland areas are more suitable for large flowering rose cultivars. However, the rate of blind shoots development is higher. Lowland areas are more suitable for intermediate and small flowering high productive rose cultivars, as the higher growth rates result in higher production levels.

Make trials to see response

There can be substantial differences between rose varieties regarding the response to certain bush management practices. Therefore it is recommendable to set up small trials to test different bush management practices and their impact on and response to the specific variety that is grown. Especially undercutting and the influence of the different seasons (e.g. cold periods during rainy season) have diverse effects per variety. Designing and executing simple bush management trials with good record keeping and plant labelling, will provide additional information for developing a proper bush management strategy.

9.3.2 Planting of a crop

Season

In Ethiopia the dry season starts in October and ends in May. There is a rainy season in the period from June to September. The best time for planting a new crop is about 2 to 3 months before the rainy season starts. During the rainy season light conditions and temperatures are low, which results in a slow start of the crop and a rigid plant for which it is difficult to perform the first bend. During the summer season, special attention should be given to the humidity in the (relatively empty) greenhouse. The relative humidity / vapour pressure can be improved by simply wetting the paths and beds and by limiting ventilation.

Different kinds of planting material

In general, three types of planting material for roses are available: cuttings, top grafts and stentlings. In choosing the type of planting material, aspect regarding costs, quality and production should be taken into consideration. Cuttings are less expensive than rootstock material (top grafts, stentlings) and reach good production levels earlier in the first year. Rootstock material performs better under warm and dry conditions, withstands better adverse circumstances (e.g. diseases), and produces longer stems, better coloured flowers and better quality and quantity on the long run.

Quality of planting material

When ordering or receiving the planting material for setting up a new crop, there are several issues to pay attention to. First of all the young plant should have one leaf with at least five small leaflets and the leaf should be intact. A dormant bud should be present to ensure the planting material is of good quality; and the roots should be healthy (white coloured), undamaged and free of any diseases (e.g. agrobacterium). Buying licensed plant material is the first condition to guarantee good quality.

Planting

Preparing the soil for planting is already discussed in chapter 6 (see section 6.3.2). The density with which the rose plants are planted in the greenhouse (plants m^{-2}) has an effect on production rate and quality. In general, three plant densities can be defined: high, medium and low. In table 9.1 below the production and quality effects for the three most common plant densities in Ethiopia can be found.

Table 9.1: Production and quality effects for different plant densities

Plant density (/m^2)	Production and quality effects (/m^2)
High (8 – 10)	More stems in the 1st year; poorer quality later
Medium (6 – 7)	Fewer stems in the 1st year; better stem quality later
Low (< 6)	Good quality; low production

After planting

Immediately after planting, break out any present buds to stop the energy of the young plant going into bud and flower development. When the bud is removed, apical dominance is abolished and assimilates are used for development of ground shoots and leafs to strengthen the leaf stock (LAI). Although this treatment reduces flower production in the first months, it will result in higher productions in the coming years.

In the first stage after planting it is important to maintain the air humidity (RV 75-85% and limit ventilation, in order to keep the crop moist, develop large leaves and prevent the crop from becoming rigid and woody. Humidity can be maintained by brushing. Radiation is allowed to be high to initiate growth, crop activity and develop a strong crop. 24-h temperatures of around 23°C are allowed, to assure fast development. However, it is important to assure the plant can still evaporate to prevent leaf burn and overheating. Frequent irrigation and brushing at high plant activity is thus important.

First bend

About 4 weeks after planting it is time for bending the primary shoot. The exact moment can be determined by the development of the suckers. At the moment the suckers show significant growth and start to develop small buds, the primary shoot is ready to bend. When bending the primary shoot, 2 or 3 new basic shoots have to develop from below the bending point to ensure the new basic shoots sprout from the ground shoot. Therefore it is important to bend the primary stem as low as possible. Stimulating the development of ground shoots will ensure thick and strong stem development and thus good quality. Maintain around 2 or 3 new basic shoots. If additional growing points / shoots develop, remove them. In Ethiopia, bending towards the path is common practice (Fig. 9.3).

Figure 9.3: Bending towards the path

Initial development and maturing of the crop

After the first bend, it is important to create an optimal crop structure. When the first basic shoots are ready for harvest, perform the first cut above the second 5-leaf, so two new stems can form from each of the first basic shoots. After the first cut, make sure to maintain enough leaf area (by bending thin, short, unmarketable stems). The second cut is done on the following first 5-leaf, but also depends on cultivar, season and location.

9.3.3 Growing strategy and crop management

Staggered / flush

The choice between staggered cropping or flush cropping is the choice between continuous production or peak production. Continuous production implies maintaining a constant uptake of light, water and nutrients by the crop and results in the highest possible year round production. Producing in flushes implies a cropping strategy with high production peaks and periods of low production in consecutive periods, and in general has a 20% yield reduction (quantity and quality) as compared to staggered (continuous) cropping.

The yield reduction is caused by inefficient use of inputs, i.e. too few inputs (light, small leaf area) and high demand for assimilates (vigorous growth) at the start of the flush and a surplus of inputs and low demand for assimilates at the end of the flush (near or after harvest). In other words, inputs are unevenly distributed during crop growth and a lot of potential growth is lost.
However, in case of seasonal market demands a flush cropping strategy can be more profitable than staggered cropping, when the harvest of a flush can be planned exactly in the period of high demand for roses and thus the highest price per stem is received (e.g. red varieties during Valentines day, 14th of February).

Strategy to stagger the crop:
1. When the crop is going into flush and if most of the stems can be harvested within 7 days, disbud thin, short unmarketable stems and let the suckers grow
2. Wait until the good stems are harvested and new stems are growing (minimum 15cm), then bend the disbudded stems, including suckers
3. Don't bend bottom shoots, but pinch them in an early stage
4. When crop has enough bend stock, remove remaining thin, short unmarketable stems

> ⓘ **Remember:**
> Disbudding (unmarketable) stems will cost production for the short term, but increases production for the long term.

Strategy to flush the crop:
1. Determine the desired data of peak harvesting (take into account days of processing, transport and preparing for market until the peak sales data)
2. Make sure the crop is in full production of newly developing rose stems in a period of about 5 to 6 weeks in advance of the desired harvest date (period from start of bud / stem development until the stage ready for cutting varies per cultivar and depends on climatic conditions). The actual harvest is mostly spread over a period of 4 days for harvest, storing and preparing for shipment.
3. A crop in full production can be realised by pinching / cutting all rose stems that are between 40% - 75% of their development phase (with start bud development: 0%; ready for harvest: 100%). This will ensure that all roses are ready for harvest at the same time (peak harvest)

Cutting and harvesting

There are four main methods to cut harvestable roses, based on different cutting heights: 1) knuckle cut, 2) on a lip, 3) leave cut and 4) under cut. The choice for a specific cutting method differs during the growing season and will depend on growth strategy, the current state of the crop, demanded quantity and required quality.
New shoot development and related quantity and quality are mainly determined by cutting strategy and the amount of leaf mass (LAI). Sink and source relations also play a role. At the moment a harvestable stem is cut, the assimilate transport towards it is stopped, the sink-source system changes and redistribution of assimilates within the plant occurs. Subsequently, the removal of apical dominance by harvesting a rose stem leads to eye break out at the highest point of the remaining stem and a new shoot is formed, where assimilates are transported. In this way the cutting strategy determines location and characteristics of the future harvestable stems, i.e. past cutting actions determine crop production for the future.

Bending

Maintaining a right amount of bend/leaf stock (LAI) is very important, since it is the rose crop's energy producer. Preferably thin, short and unmarketable stems should be used for increasing or refreshing the bend stock. However, sometimes, when no thin, short or unmarketable stems are available, it can be important to sacrifice several marketable stems to maintain an optimal LAI to ensure the crop leaf stock remains photosynthetic active and produces sufficient assimilates. This will cost production on the short term, but increases production on the long term.
After a flush, do not immediately bend all the leftovers or thin, short and unmarketable stems, but disbud and let the suckers grow to create leaf mass for photosynthesis. Upright stems catch more sunlight and therefore photosynthetic rate and assimilate production are higher This will cause less stress and helps the plant to survive. Bend the stems when the leaves turn green.

Refresh the bend stock regularly, as young fresh green leaves are the most photosynthetically active. Older leaves are less active and over time consume more assimilates than they produce. Therefore the older bend stock (yellow / brown leaves) should be removed and replaced by fresh material through bending regularly. Old residual bend stock also increases the risk for development of pest and diseases.

Desuckering
Desuckering is a technique with which the small side branches (suckers) are removed from the rose stem. This is done by carefully breaking of the sucker by hand as close to the rose stem as possible, in order to leave a clean break off. Breaking off very small suckers (< 2cm) at the top of the rose stem is risky, because of the risk breaking off the top and bud of the rose (making it unmarketable), so they are best left on the stem. The extent of sucker development is variety dependant and a young crop will develop more suckers than a more mature and already established crop. Development of suckers indicates that the crop is vigorous and has a good root system. However, development and growth of suckers also use up precious energy and therefore should be removed regularly. The number of times a week the crop needs to be desuckered, depends on several factors, i.e. location, season and rose variety. In general, for highland areas it is recommended to desucker the crop every week, for lowland areas 2 times a week

Pinching
Pinching is a pruning technique, by which the tip of a growing stem is removed and apical dominance is broken. The growing point is removed before flowers can develop. Pinching is used to correct a crop in flush, when too many short and thin (unmarketable) stems are produced. Selective pinching (e.g. pinching of about 20% of the shoots from each plant in one week and another 20% the next week, leaving the balance of 60% to go straight into bloom) will result in a delay of the expected flowering period of the pinched stems (2 - 3 weeks), in order to stagger the crop. A crop that is well maintained with proper bush management in general does not require pinching correction.
Depending on the extent to which the crop needs correction, soft pinching or hard pinching can be performed. Soft pinch implies removing just the tip of a new shoot that is not yet showing any sign of flower bud formation. It results in maturing of the red purplish leaves to green within a week and re-sprouting of the upper eye and an extended flower stem. With soft pinching the flowering is delayed by about two weeks. Hard pinching implies removing the upper part of a soft shoot with two to four leaves. The remaining purplish leaves will turn green within a few days and new shoots develop in the upper two or three leaf axels. With hard pinching the flowering is delayed by about three weeks and results in longer stems as compared to soft pinched stems and non pinched stems. The side effect of pinching is reduction in quantity, quality, bud size and vase life. In Ethiopia, soft pinching is most common.

Blind shoots
Development of blind shoots is in almost all cases a waste of the available energy of the crop. The degree of blind shoot development is partly variety dependant, but can be reduced by taking into account several aspects:
- Blind shoot development is variety sensitive and depends on the power to grow
- Competition between shoots and apical dominance plays a role
- The development of blind shoots is influenced by the level of light, level of CO_2 and temperature
- Hormones possibly play a role
- Cropping strategy (flush / staggered cropping) is of influence
- Type of cut point plays a role

In Annex 17 the above mentioned aspects are explained in more detail.

10 Growing for market demand

10.1 Introduction

The flower market is very dynamic. Consumption and trade patterns change and market requirements are becoming increasingly important, forcing growers to focus on one particular market segment. Large retail chains comprise one of the fastest growing flower outlets. Ethiopian flower exporters can either target these retail chains or target the more traditional florist segments with innovative products by answering to one or more of the trends identified in this module.

10.2 Fulfilling market demand - segments and requirements

Ethiopian growers have to realise that the quality expected by European consumers is generally extremely high. They expect not only freshness at the moment of purchase, but also that flowers open up and have a long vase life. Although the price is not always the main criterion, it is of major importance, particularly in these days of stagnant economies.
Top quality flowers in fashionable colours and shapes are generally priced higher than the average crop. The traditional primary colours of red, yellow, orange, pink and white always enjoy a certain demand, but the ever-changing fashions set the trends. Many consumers prefer bi-coloured over mono-coloured roses.
The lion’s share of Ethiopian flowers is exported to The Netherlands. These flowers, however typically end up all over Europe (and the rest of the word). Consumer preferences and patterns can differ strongly between EU countries and even within countries by geographical region and income strata. People with above average income tend to buy more exclusive flowers and are generally more interested in social and environmental aspects. In general, consumers are very interested in variation in personal gifts. They like to be surprised. Growers play into this trend by continuously introducing new varieties.

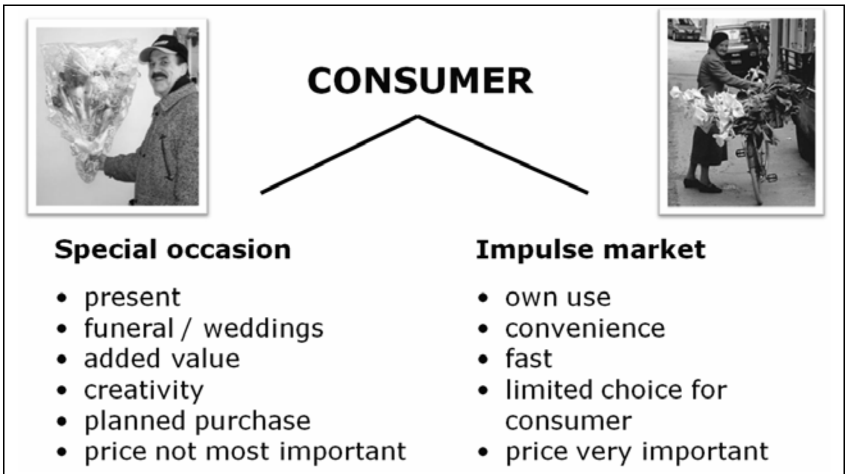


Figure 10.1: Two distinct reasons why consumers buy flowers

The past decade has seen a strong rise in purchases of flowers for own use. These purchases are often so-called impulse purchases pushed by large retail chains, which have gained significant market share in many EU countries. Most products sold in this market segment can be characterised as sharp-priced bulk varieties, mostly smaller varieties (sweethearts and small intermediates), but also shorter-stemmed (40-60cm) larger varieties (large intermediates). In recent years, supermarket sales have started to shift towards larger sizes, offering interesting opportunities for Ethiopian growers.
The growth of this own-use market segment should not be seen as a shift away from gifts and special occasions, but rather as the development of an alternative market segment. In the EU, most flowers are still bought as gifts for special occasions. Florists remain the main retail outlet for this segment, while more impulsive purchases occur at large retail chains. As a result, large roses are still predominantly sold at the florists. Here, preferred stem lengths can vary from 60 up to 100 cm and even longer.

Following this segmentation on consumer and retail level, also wholesalers are increasingly specialised in supplying one specific market segment. Traditional wholesalers with their fine distribution network are able to offer florists a full spectrum of top quality products. Other wholesalers, the so-called 'flower providers', concentrate on offering retail chains large volumes, guaranteed availability and even complete category management services.

Table 10.1: Specific needs of the two distribution systems

Florists (special occasion)	Retail chains (impulse purchase)
- Product quality - Fine distribution network - Wide and deep assortment - Demand for new & exclusive assortment - Market prices	- Mass distribution - Small assortment - Guaranteed availability of assortment - Guaranteed prices - Product safety (CSR, tracking and tracing) - Social and environmental standards

Each market segment features a set of specific needs, which have to be fulfilled by all players in that channel. Rose growers need to understand in which market segment they operate and fulfil the relevant requirements (see also Chapter 1 on how prices are set).

10.3 Commercial relation management

Each farm is up against a continuous challenge: acquiring customers and keeping costumers. Export farms that think that they can temporarily put off this challenge, know that they will get into trouble in time.
In theory, organisations acquire customers and keep customers by means of their product and services package. These packages are put into the market with a marketing mix. The basic four P's will be presented well by almost all companies: Product, Place, Price and Promotion. In modern flower trade, however, these basic four P's do not constitute decisive selling points anymore, since the customers do not expect other than that these four P's are well presented.

The real distinctive characteristic of a farm lies in four other P's:
- *Performance:* How do you and your farm present yourselves to the customer, at one hand, and to your colleagues on the other hand?
- *Personal information & -sales*: What strategy is used for customer approach and how do you and your colleagues realise this?
- *Positive mouth-to-mouth advertising:* What is the image of your farm, your products and yourself, how do you stimulate mouth-to-mouth advertising?
- *Personal attention:* To what extent do you show sincere interest in your relation, but also: how customer-oriented and customer-friendly are the other co-workers within your organisation?

Relation management

Aforementioned four P's are related to relation management, creating long-lasting customer relationships and building a positive company image. Acquiring genuinely satisfied customers, that is what it is all about! Genuinely satisfied customers ask more, take care of positive mouth-to-mouth advertising and this concept also leads to more pleasure in work for you and for your colleagues.

> ⓘ **Did you know?**
> - A bad experience is told twice as many times as a good one (negative mouth-to-mouth communication)
> - Acquiring a new customer costs four times as much as keeping an existing customer

Customer-oriented organisation

In a customer-oriented organisation everybody is involved in a process of continuous improvement and innovation based on: acquiring satisfied and returning customers and, therefore, a solid relation. In the following model, the fishbone model (see figure 10.2), we see that the customer's wishes mark the beginning of the process.

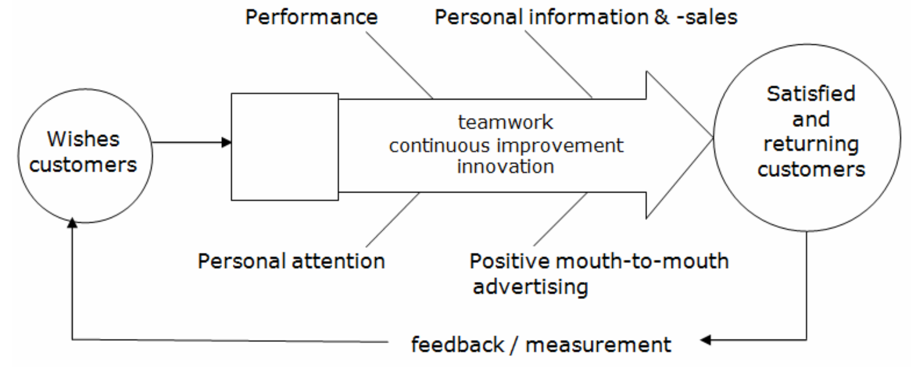


Figure 10.2: The fishbone model

Customer orientation is in fact all about resolving customers' problems and actually enjoying this process. It requires a mentality, an attitude that is acquired within limits. Customer orientation also means that you take initiatives towards (potential) customers. You do not wait until they (in most cases already too late) knock on your door.

In short
The basis for a customer-oriented organisation are the wishes and needs of (potential) customers; team work and innovation increase chances

Customer orientation is more than only customer friendliness. You could say that customer friendliness equals service with a smile. Customer friendliness may embellish good customer treatment, but cannot improve a bad one. With customer orientation, however, you are really resolving customers' problems. Customer orientation is about what you do, and customer friendliness is about how you do it.
A customer-oriented organisation provides quality. Quality is delivering what the customer wishes and expects and preferably something more. The customer judges quality according to the weakest link within your supply chain. Is your paper work incorrect, your export manager unfriendly on the phone, or is the customer's feedback not put through to the production site at all? These are essential elements that determine the customer's judgment of the quality.
Together with colleagues we work on that quality image. That is why a customer-oriented organisation considers teamwork (read: internal customer orientation) as the basic competence. Your company may realise its external marketing so well, but it will be no good if the internal marketing does not fit in, so that they are in balance. We must not only live up to what we promise the customer, but also promise the customer what we can live up to.

Customer value
Each organisation has a certain selling formula. With this formula the organisation tries to reach and bind a certain public. Satisfied customers usually return and provide good turnover. Reaching new clients costs a lot of time and energy. It is, therefore, important that you treat your existing customers well. This means that you know what your clients expect from you and your organisation, and exactly why they buy flowers from you. We call these purchase motives customer values. Customer values may refer to various issues:

- Specific varieties or broad assortment
- A specific service you can offer
- Price quality ratio
- Only one business partner to deal with
- Personal relation

In short
Customer values constitute customers' motives to do business with you. You obtain this knowledge by asking yourself or your customers two questions:
- Why do you choose our company/ product?
- Under what conditions will you keep doing so?

10.4 The concept of quality

In Figure 10.3 we see the development of the quality concept:

- Step 1: quality is only seen from the end product
- Step 2: we also look to the whole production process
- Step 3: the whole organisation (administration, management, etc.) is part of the quality concept (also called Total Quality).
- Step 4: a group of companies together in the chain are making quality.

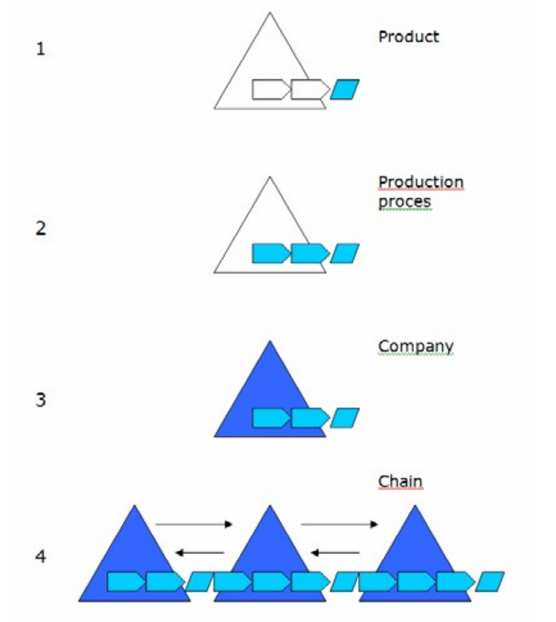


Figure 10.3: The development of the quality concept

Quality assurance is of paramount importance to all companies and organisations in the production, sale and handling of flowers. Modern trading conditions and legislation require businesses to demonstrate their commitment to quality and establish an appropriate product quality programme. Such a programme should take into account the role of the business in the chain, i.e. whether they are primary producers, manufacturers and retailers.

A product quality programme contains four primary elements:
1. Meets the expectations of the customer
2. Fits within the strategy of the company
3. Ensures that a company is clearly committed to the quality of its products
4. Aims for the highest quality level achievable

10.5 How to develop a Quality Assurance Programme

Senior management has the ultimate responsibility for ensuring that the highest standards of production and handling are achieved. Total commitment to this aim is crucial for the successful implementation of such a programme. The senior management should ensure a logical and structured approach to both organisational and product or process related activities.

A policy statement by senior management should outline the general approach to ensure production and handling of products with the desired quality. The company should make sure that the policy concerning product quality:
- is appropriate to the nature and activity of the business
- provides a commitment to continuous improvement
- complies with legislation
- is fully communicated, understood and supported by all employees

Planning

Organisational planning should include the preparation of a detailed quality assurance programme. This should clearly define aims, assignment of responsibility, resources, requirements and lines of communication to gain full commitment from all personnel to the quality assurance programme. This process, through assessment and auditing, should seek continuous improvement.
Product and process planning should result in the definition of clear and unambiguous requirements, for example with respect to size, quality, colour, safety. All such requirements should be based on a full consideration of constraints, opportunities and other relevant factors.

Implementation

The first requirement is a thorough understanding of all stages of the production cycle from cultivation, post-harvest and logistical issues through to the final products and their use. This will include a

detailed knowledge of product-process interaction, product and process specifications, monitoring and verification procedures and methods for dealing with non-compliance. With this knowledge, a detailed analysis can be undertaken to identify those factors which may affect quality. Appropriate control measures can then be identified and implemented.
It is essential to fully document this analysis which will describe the procedures to ensure compliance with quality assurance requirements and the operational criteria necessary for product and process control.

Audit and improve
Senior management should ensure that there is a process of regular assessment of performance of the quality programme. This can be done internally and will include audit of individual stages and identification of any weaknesses. In this way, an assessment can be made of whether the quality assurance requirements are being met and whether the programme is truly effective.
The analysis and assessment process is likely to identify issues for adjustment, modification and improvement. These should be undertaken and appropriate follow-up carried out. This is an on-going review process designed to ensure compliance with changing regulations.

People
The farm's quality policy must be communicated to employees in such a way that it is understood at all levels in the organisation. The employees whose work affects quality must be identified; an organisation chart or job descriptions may serve this purpose. A quality manager must be appointed, responsible for development and maintenance of the quality system. This job includes, for instance, the responsibility for the writing and updating of procedures. The quality manager must report to the management. The management must check if the implemented quality system is working properly (quality review). If adjustments need to be made, it is the responsibility of the quality manager to ensure that these are put into practice.
The farm must also develop a procedure to identify the training needed for the employees to do their jobs properly. The appropriate training must be provided and training records, showing which employees attended which training, must be kept.

Information and traceability
Essential information must be recorded. Procedures must be established in order to be able to identify products during all stages of the production and post-harvest process. This identification ensures the traceability of products, for instance, in case of errors during production or harvesting. Information should be collected and kept after production and delivery in such a way that the producer can prove that delivered products met the established quality criteria and the quality system worked properly. Statistical techniques can be used to assess the quality of both products and production processes.

10.6 The art of growing roses

1. Ensure continuity in production in terms of exported quantities, quality and assortment. This will make you a reliable and preferred supplier to buyers and it will payout in terms of continuous generation of cash flow and better prices.
2. Set up a protocol and operate accordingly when it comes to stock management, including fertilizers, crop protection chemicals and packaging materials. Always make sure you are thinking ahead and have all possibly needed inputs available in time.
3. Make decisions in cultivation practices based on data in combination with an interpretation of the circumstances. Collect data from soil or substrate analyses, weather information and scouting reports, and use this information to make adjustments in fertilization management, pest management and bush management. Do not forget to take into consideration the seasonal conditions and the condition of the crop at that moment.
4. Register data digitally. This creates the possibility to make analytical tools, to look back on what happened last year and improve your current cultivation strategy based on this information.
5. Invest in knowledge and training for management and employees. Train them (or have them trained) in how to collect and interpret relevant data and how to turn this information into practical

measures. Be aware of creating sufficient 'space' in the organisation for them to be able to use their knowledge and experience.

6. Invest in good communication, especially between the production farm, the (head office, your consultants and sales partners. Use market information, advice from external parties and feedback from unpacking agents to make improvements at the farm. This means head offices should be in continuous contact with the sales partner on how to improve the exported product and in daily contact with the farm management to discuss necessary improvements and adjustments. In this way a farm can maximize its profitability.

10.7 Business case: Towards production for the direct market

Company : Yassin Legesse Johnson Flower Farm
Location : Debre Zeit
Production area : 11 ha
Main varieties : Red Ribbon, Athena, Orange Fizz, Tenga Venga, El Toro, Sonrisa, High and Yellow Magic, High and Orange Magic, Duett

Yassin Legesse Johnson Flower Farm is located in the Debre Zeit area and follows a market strategy focused on expanding production share for direct sale. In the near future they will fine-tune their variety assortment to specific rose varieties that accommodate their customer's wishes. Production manager Haile explains about selecting the right varieties to grow:

"When selecting a new variety, market price and direct market demand plays a major role. The price of a variety for direct sale is determined based on the price at the auction. Furthermore, before planting a new variety we always want to see in advance how it grows. Therefore we visit other flower farms which are growing the variety, if possible in Ethiopia or otherwise in Kenya. If no other companies are growing the variety, we do trials on our own farm. At the moment we are doing trials on our farm with the variety Good Times, to see how it grows, to estimate potential production and to find out what are the weaknesses of the variety"

Currently at Yassin Legesse Johnson Flower Farm 40% of their production is for direct sale and 60% is still going to the auction. In the future they want to expand the production share for direct sale. Haile explains:

"The advantage of producing for direct sale, is that the price is agreed upon and known in advance. If you send roses to the auction, you just have to wait and see what price you will get. Furthermore, direct sale also accepts the shorter stem lengths. At the auction the short stem lengths get a much lower price and in general the auction has stricter quality requirements"

Their market strategy for expanding production for direct sale includes replacement of the bicolour varieties (Duett, High and Yellow Magic, High and Orange Magic), with more standard colour varieties. Haile says:

"Bicolour varieties are less attractive for the direct market. The demand from the direct market is more focused on the more standard coloured varieties. Furthermore, we will focus on intermediate varieties, as the pack rate is more efficient than with large flowering varieties and thus airfreight costs are lower and profits are higher"

Yassin Legesse Johnson Flower Farm is planning to expand with 7 ha of greenhouse in the future.

10.8 Business case: Market strategy - auction vs. direct sale

Company : Tinaw Business
Location : Wolkite
Production area : 13 ha
Main varieties : Mariyo, Marie Claire, La Belle, Belle Rose, Upper Class, Athena, Blondine, Viva, Heidi

Tinaw Business is located in the Wolkite area (100 km south west of the Sebeta region). Because of their location they can grow high quality roses and therefore they are focussing on production of large flowering bicolour varieties. In 2012 they are planning to expand their farm with 10 ha of greenhouse and add a lot of new varieties to their assortment. Production manager Ashok explains:

"We want to expand our assortment with a lot of new and exclusive varieties, with each variety grown on a smaller area. In this way we want to reduce focussing too much on a few varieties, in order to lower the risk of low demand and high supply at the auction for certain varieties. Our market strategy is preferably production for the auction. Only short stem lengths are interesting for direct sale. If you produce high quality roses, you get the best price at the auction"

Despite his preference for auction sale, Ashok thinks that the importance of direct sale will grow in the future. However, he adds that direct sale can also be done through the FloraHolland auction's FloraHolland Connect service. He thinks the auction will always stay important for the sale of roses, especially in case of new varieties and building you reputation and name as a farm.

11 Farm economics

11.1 Introduction

Economics are the basis for each company. Starting up a new company implies a financial calculation to identify the variable (operational) costs revenues and the investments. As a result, a financial calculation can be made on the Cash Flow of the company. This Cash Flow is important in communicating with financial institutions or with investors.

Organising record keeping on the farm level, knowing your cost price, knowing your financial situation and having awareness of financial opportunities and threats, all have both strategic value (markets are changing very fast) as well as operational / financial value (especially in case of weak and vulnerable operations).

The financial situation can be monitored very accurately if a business plan has been made. This business plan should contain the following items:

- Investment overview
- Investments per year
- Financing
- Plant schedule
- Production and sales
- Production and sales per variety
- Variable costs
- Variable costs per variety
- Fixed costs
- Profit and Loss account
- Return on Investment

Basic decisions are related to the investments, the choice of the varieties, the price of the planting material and royalties and the variable costs (including transport) and revenues. If there is a basic budget per year calculated for these issues, the Cash Flow and financial sourcing can be estimated.

11.2 What's a cost price?

The simple definition of a cost price is the sum of all costs, made during the production and marketing stage of any product (or service) and/or costs that can be attributed to that production and marketing. Different approaches can be followed and different cost aspects can be considered, ending up in the price per item. Several cost price elements can be distinguished next (see table 11.1 for more details):

Operational costs:

- *Variable costs (costs of sales):* those current costs which are incurred in actually growing and marketing the products; these costs are variable which means that they vary directly with the volume and/or quality of the output;
- *Farm labour costs:* those labour costs which are directly related to the production processes at the farm; all expenses are included: salaries, social fees, pension payments, vacation payments etc. These costs are partly fixed and partly variable
- *Overhead costs (fixed costs):* necessary costs to support the growing (repair and maintenance, electricity), management (consultancy, communication, administration, insurances) and marketing (travelling)

Investments:

Those (fixed) expenses which are related to the investments and the financial consequences of financing. The costs related to the investments are depreciation and costs related to loans or other types of funding. These costs are considered as fixed costs.

Table 11.1: Sales, costs, cash flow and profit & loss

Sales and costs		
Income out of direct sales		**A**
Income out of direct sales in EURO = number of exportable stems * market price in EURO Income out of direct sales in US$ = sales in EURO * exchange rate		
Freight costs & packaging costs		**B1**
Freight costs = number of boxes * kg per box * price per kg (door to door = car, truck, plane, ...) Packaging (material costs of boxes, paper, foliage etc.)		
Other variable costs		**B2**
Chemicals & fertilizers Direct marketing Auction & unpacking costs		
Total variable costs (costs of sales) , excl. labour costs	**B1+B2**	**B**
Gross margin (total sales minus costs of sales)	**A-B**	**C**
Labour costs		**D**
Direct production (farm costs): those labour costs which are directly related to the production processes at the farm; All expenses are included: salaries, social fees, pension payments, vacation payments etc.		
Overhead costs		**E**
Energy (electricity, fuel etc.) Repair and maintanance Consultancy fees (production advice, lawyers, auditors etc.) Communication (computer, telephone, radio etc.) Administration and bank costs Insurances and licenses Foreign travel		
Operational costs	**B+D+E**	**F**
Investments, re-investments, replacements		**G**
Land & infrastructure: land, land clearing, fencing, bore hole(s), offices, stores, electricity infrastructure, transformer, … Production facilities: greenhouses, irrigation system, fertilization system, plants, royalties, sheds, equipment, coolers, … Vehicles and equipment: truck(s), stand-by generator, office furniture, office equipment, communication equipment, tools, …		
Yearly costs related to investments		**H**
Depreciation costs = sum of all investments * yearly depreciation (%) Interest costs = bank interest rate * borrowed capital		

Cashflow		
Value of (re-)investments and replacements		**G**
Operational costs		**F**
The total yearly outflow is the sum of (re-)investments and replacements and all operational costs	**G+F**	**I**
The total yearly income is your annual sales (turnover)		**A**
The cashflow is the total yearly income minus the total yearly outflow	**A-I**	

Profit and loss		
Total sales (annual turnover)		**A**
Operational costs		**F**
Depreciation & interest costs		**H**
Total annual costs	**F+H**	**J**
Profit before taxes and loan servicing	**A-J**	

11.2.1 Why keep records and calculate a cost price?

Young, newly started companies usually are production oriented, having no or little management information and no or little market information. During the development process of companies into a mature stage, the focus is directed more and more towards the market.

In the first, production oriented stage, knowing cost prices doesn't have priority and even is hardly possible. In the market oriented stage of a company, knowing the cost price is a prerequisite to survive. In this stage you need to have records and insight in the performance and results of all departments, insight in the market and its trends, insight in your competitors, etc, etc.

Calculating and actually knowing your cost price:
- Gives you insight in your (labour) productivity;
- Informs you what to improve in your organisation;
- Will prepare you better in negotiations;

- Gives you better inputs in your strategy decisions;
- Increases your competitiveness (as an individual company and as a group or association;
- Will bring you profit more easily.

11.2.2 What is important in cost price calculation?

Calculating and knowing your cost price is just one of the elements of good management in a market oriented company. A relatively simple calculation schedule can be used (see figure 11.1). According to the experiences, the next elements of the calculation and allocation caused difficulties or confusion:

Record keeping
It's clear that any calculation to define the cost price requires (internal) data. Meticulous record keeping is a prerequisite to reach reliable figures. Don't fool yourself. And be aware that record keeping is necessary anyway in your quality management and in your never ending search for cost price reduction.

Calculation and allocation of overhead and management costs
The fees for owner(s), the board and/or the higher management usually are taken into account separately; this cost factor can be a debatable issue but think about it whether to add it or not to add it in your cost price.

Calculation and allocation of costs related to investments
- Interest: Interest costs should be calculated over the total invested capital (including working capital), whether you have loans (from banks or other sources) or not. A way to calculate is multiplying the interest rate (%) by half of the replacement value. Suppose you buy a packing machine for US$ 10,000 and the interest rate is 12%: your interest costs are 12% * 10,000 * 0.5 = US$ 600 every year;
- Depreciation: The yearly depreciation costs of your investments depend on the lifetime of the (fixed) assets. Buildings usually last for 15-20 years (5-6% yearly depreciation), wooden greenhouses 5-10 years (10-20% yearly depreciation), mother stock 3-10 year (10-33% yearly depreciation), computers – hardware 2-3 year (33-50% yearly depreciation) and software even 1-2 year (50-100% yearly depreciation);
- Bank: Apart from interest costs, the bank might charge you with fixed or variable costs like commission and/or fees for your financial (international) traffic.

11.2.3 Cost price calculation format

DLV Plant has developed a cost price calculation format for rose production, which enables easy cost price calculation by filling in the requested data. In Annex 18 the different components of the calculation format are included. All data used in the cost price calculation format has to represent a period of 4 weeks and all costs, unless noted otherwise, are in Ethiopian Birr. Below an overview of the different components and required input data needed for the cost price calculation are given:

Info
- Company details
- Today's currency rate
- Rose varieties

Fixed costs
- Energy: electricity, gas / oil / fuel
- Maintenance exc. labor: greenhouse, water supply / irrigation, fertilization / crop protection, cold store & post harvest, vehicles & machinery, unforeseen
- Other: insurance, lease, royalties

Labour costs
- Salary paid per period of days
- Number of employees per position
- Average gross-salary per position

- Labour positions: management, supervisors, greenhouse, packhouse, spray, irrigation, maintenance, other

Additional costs (variable)
- Crop protection: chemical products, biological products
- Fertilization: chemical products, biological products

Packing
For each rose variety:
- Stem length
- Stems per bunch
- Rubber band: amount purchased, purchase costs, number per bunch
- Wrapping paper: amount of wrapping paper per roll, price per roll, amount per bunch
- Transport box: bunches per box, price per box
- Box strap: amount of strap per roll, price per roll, average length of one strap, number of straps per box

Export
For each rose variety:
- Unpacking costs: handling, transport, marketing %
- Auction costs: tax per bucket, number of stems per bucket, cart tax, buckets per chart, shipment tax, membership %
- Transport Ethiopia per box: road transport, customs, handling airport, air-freight (per kg), fuel charge
- Transport Netherlands per box: handling airport, customs, road transport
- Kilogram per box

Turnover
For each rose variety, stem length and auction day:
- Amount of roses
- Price of roses

Profit
When all above information is entered in the cost price calculation format, for each rose variety and length the cost price, turnover and profit is calculated; the total turnover and profit for all rose varieties together is calculated; and the overall profit per m^2 is calculated.

11.3 Business case: Benefits of cost price calculation

Company : Tinaw Business
Location : Wolkite
Production area : 13 ha
Main varieties : Mariyo, Marie Claire, La Belle, Belle Rose, Upper Class, Athena, Blondine, Viva, Heidi

Tinaw Business is located in the Wolkite area (100 km south west of the Sebeta region). Tinaw Business is applying cost price calculation in order to gain more insight in how to reduce their costs. Production manager Ashok explains:

“Continous cost price calculation provides information on the exact cost price at the farm for each production period. By comparing the cost prices for each period it gives insight in how and where costs can be reduced and if certain changes in the production process have the desired effect to maximise profit. In our case we also did a cost price calculation with the introduction of integrated pest management (IPM) on our farm. The cost price calculation provided us the information to substantial decrease our cost price of IPM. Based on the information from this cost price calculation we decided to start on farm reproduction of the biological control agent Phytoseiulus Persimilis, for controlling spider mites. One other conclusion from the cost price calculation was that growing roses with stem lengths of 70 cm is more profitable than growing 80 cm stem lengths, as the pack rate for 80 cm roses is lower and ultimately result in less profit as compared to 70 cm stems. However, this will also depend on the time of the year and the price at the auction determined by supply and demand, but this can be included in the cost price calculation”.

Ashok adds that the next step in cost price calculation will be to compare cost prices between greenhouses.

12 Corporate social responsibility

12.1 Introduction

Traditionally, managers have been expected to have knowledge about, and experience in, conventional management fields such as finance, human resources, accountancy, economics, production and (more recently) information technology, to mention a few. All of this was considered necessary in order for a company to successfully pursue its main goal – profit for the shareholders through the creation of economic value, as a direct result of satisfying the needs/wants of consumers/clients.

However, an increasing number of floricultural companies are appointing a "Manager CSR" or "Manager Corporate Social Responsibility". Additionally sector associations are beginning to realise the importance of a sustainable future in their industry, e.g. EHPEA Code of Practice. Flower producers, wholesalers and retailers are concerned about the image their products have with the consumer and are also taking steps to avoid negative publicity.

12.2 Defining CSR

Corporate Social Responsibility (CSR) or Sustainable Development (SD) is currently a much discussed topic. But what is CSR, how do you implement CSR, is it a hype or is it here to stay and can it have dramatic effects on a company if it is not "doing" it (market implications), how does it relate to certification/labels (if at all)? One thing is certain, it is very important that management grasps these issues and sees the need to integrate CSR into every facet of the business – business as usual and donating money to a good cause is not good enough!

In the 'Guidelines for Multinational Enterprises' drawn-up by the OECD, it states the following in regard to what CSR is: "Enterprises should take fully into account established policies in the countries in which they operate, and consider the views of other stakeholders. In this regard, enterprises should contribute to economic, social and environmental progress with a view to achieving CSR".

Another answer to the question "what CSR is?" is: a company takes on a visible role in society which goes further than its core business or doing what is required by law, *and* which results in added-value for the company and society.

Here the premise is that running a business is a "social" activity, benefitting society by providing goods and services, at the same time offering employment which allows for personal development, which again benefits society – in this way linking what businesses do to effects in society.

Finally, Milton Friedman sees the social role of companies in a market economy as being limited to:

> "To use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the games, which is to say, engages in open and free competition, without deception or fraud".

However, CSR should be seen in the broader context of what has been termed corporate citizenship:

> "A company should behave like a good citizen in business. The law does not (and cannot) contain or prescribe the whole duty of a citizen. A good citizen takes account of the interests of others besides himself, and tries to exercise an informed and imaginative ethical judgement in deciding what he should and should not do. This, it is suggested, is how companies should seek to behave."

All of the above definitions refer to economic, environmental and social aspects. It is therefore not surprising that, in explaining CSR, it is frequently referred to as relating to the 3 P's or Triple P.

12.2.1 Examining the 3 P's

Just as any business, a flower farm is considered to be a value creating entity. Businesses create value by producing goods and services which contribute to society's prosperity by satisfying needs. In addition, they form a source of income for entrepreneurs, employees and investors. In this way, a farm is an important supporter of society's development. At the same time, value (such as related to nature/environment and the well-being of people) may be damaged or lost through the production and trade in flowers.

The goal of sustainable development is to ensure future generations are also able to pursue and attain prosperity. In keeping with this goal, CSR would require companies' activities to be aimed at long term value creation on three fronts: not just financial/economic aspects (such as profitability), but also with regards to environmental and social aspects. In other words, companies must be guided by the results achieved in each of the three dimensions (people, planet, profit).

Profit

Profit relates to value creation by producing goods and services and by creating employment and sources of acquiring income. The financial return reflects the appreciation of buyers for the company's flowers as well as the efficiency with which production factors are used. Striving to achieve profit (in the long run) must provide the financial foundation for continuity of the business. Profit therefore, is simultaneously, the foundation for shaping and dealing with the other two dimensions, as well as being an essential precondition.

People

The social dimension of CSR consists of a whole range of aspects and is both internal (aimed at personnel) as well as external (society). Taking care of this dimension starts with good employer-employee relationships and human resource management. Increasingly, flower farms in Ethiopia need to find ways to motivate employees and prevent a high turnover of staff. Furthermore, the social dimension can include the company's direct surroundings. The farm can consider contributing to improved working and living conditions, and getting involved in neighbourhood projects for example. Finally, the social dimension has to do with respecting human rights and fundamental labour standards/laws.

Planet

The environmental dimension of CSR means that care for the natural surroundings is integrated into the daily running of the company (as with the social dimension referred to above). It is therefore extremely important that insight is gained into which activities result in a negative impact on the environment and that alternatives are sought in for instance use of pesticides to reduce this negative impact. In other words, farms need to move from being reactive to being pro-active, seeking ways to limit and/or prevent the burden to the environment.

Following this definition of CSR and the 3P's, it is important to consider what this means for your business. Flower exporters are increasingly confronted by buyer demands including requirements regarding the environmental and social aspects under which production takes place. There is a growing emphasis on terms such as "fair trade" and "transparency". More and more, producers are asked to comply with certain requirements and be willing to have inspections (audits) take place so that this compliance may be checked. Apart from an explosion in international schemes, labels and initiatives – supermarkets and other chain stores have developed their own "in-house" schemes (such as Tesco's Nature's Choice). Furthermore, branch organisations have developed "Codes of Conduct" their members are expected to adhere to – often also having to undergo inspections.

Companies need to consider what is relevant for them (depending on who they sell to) and – in particular – how they can comply with these requirements in a practical, relevant, workable way and still run a profitable company.

It is vital to understand that the impact on your business of certification schemes, labels and codes of conducts is two-sided. On the one hand, it is a *management tool*, and on the other, it is a *marketing tool*. As a management tool, it allows information gathering and insight into how things are done, what is used in the production process etc. Thus, enabling management to identify areas where efficiency may be improved, alternatives sought and cost savings made. As a marketing tool, it allows for differentiation – the company can use the fact that it complies with certain criteria to differentiate itself from competitors (competitive advantage) because it 'says' something about the company. Thus, offering its clients added-value. This last point is often overlooked by companies. They tend to wait for clients to impose requirements, rather than implementing a number of policies in such a way that they can promote themselves to (potential) clients not only as being a reliable supplier of a quality product, but also as being a good “corporate citizen”.

The brochure ‘Inspiring practices in corporate responsibility’ contains guidelines and practical tips about CSR. The brochure can be downloaded at:
ⓘ www.netherlandsembassyethiopia.org

12.3 Waste Management

Waste disposal is still a major problem related to the production of roses in Ethiopia. While there is no regulated or some kind of centralized public or private pick up and processing service for horticultural waste in place, the current system of waste disposal in Ethiopia is ineffective and environmentally unfriendly. On farm waste treatment systems are also not common practice. A proper regulated and processing service for waste disposal is therefore desirable. Waste from horticulture can be divided in solid waste and liquid waste.

Solid waste
Solid waste includes pesticide containers, chemical fertilizer packaging, polythene greenhouse films and other plastic or waste materials from rose cultivation. Currently the most common waste treatment practice for solid waste is: 1) rinsing and puncturing of package material (to prevent reuse), 2) temporary storage and 3) burning and/or burying in a pit on a desolate part of the farm. However, on the long term this is not a suitable and hygienic way of waste disposal, since chemical residues and harmful substances can easily enter the environment.

Liquid waste
Liquid waste concerns mainly effluent and wastewater from flushing drip lines or cleaning spraying equipment. Mostly wastewater is disposed in ditches or designated areas, although it is an environmentally unfriendly practice. Another option for liquid waste disposal is to collect waste water into a basin where it sits for a while and deactivation of the chemicals can take place, before it is released into a ditch. However, during the rainy season the waste basin can be overloaded and waste water may spill into the environment or into a neighbouring basin from where the water is used for irrigation. Also disposal of waste water into pits filled with charcoal are used to deactivate some of the active ingredients from chemicals, but still does not prevent chemical residues entering the environment.

12.4 Which flower standard is relevant for you?

Ethiopian producers targeting the European market are faced with this abundance of standards and need to make a decision which certificates are relevant for their export business to become successful.
The European trade in floricultural products is nowadays strongly characterised by the existence of a multitude of social and environmental standards in the form of certification schemes, codes of practice and a handful of consumer labels. One of the reasons for this large number of co-existing certificates is the fact that retailers tend to adopt those standards which best meet their needs. There is even a strong trend among large retailers to set up their own private standards. So, although fragmented, the importance of standards in the European flower is increasing.

Table 12.1: Grower participation in standards (2010)

Standard	number of companies	hectares	countries
MPS-ABC	3,673	26,779	Netherlands (2,678), Japan (222), Belgium (150), France (124), Spain (83
GLOBALGAP	+/- 400		
MPS-GAP	227		Netherlands (172 companies), Kenya (15), Belgium (9), Uganda (8), Denmark (6), rest (17)
Florverde	170		all Colombian
FFP	160	2,130	Plants (85): Netherlands (79)

			Flowers (75): Netherlands (30), Italy (16), Kenya (14), Ethiopia (7)
MPS-SQ	145		Netherlands (109 companies), Kenya (15), Ethiopia (7), Uganda (4), Belgium (2), rest (8)
FlorEcuador	104		all Ecuadorian
MPS-ETI	95		Netherlands (73 companies), Kenya (10), Ethiopia (3), rest (9)
FLP	54	1,300	Ecuador (42), Germany (6), (Kenya (1), Chile (1), Portugal (1), Sri Lanka (1)
EKO	98	60	all Dutch
Rainforest Alliance	53		
FLO	50		Kenya (24), Ecuador (10), Zimbabwe (8), Tanzania (3), Sri Lanka (2), rest (3)
EHPEA CoP	+/- 50		all Ethiopian
KFC CoP	48		of which 9 Gold status
MPS-Florimark	42		all Dutch
Milieukeur	32		all Dutch: 27 growers of trees and shrubs, 5 greenhouse growers of flowers and plants

Source: BTC, ProVerde (2010)

In some cases, existing buyers directly ask suppliers to conform to requirements and adopt specific certification schemes. Particularly, producers serving the supermarket channel have been introduced into certification this way. Other farms have gathered a collection of certificates hoping to find new customers and tap into new market segments.

For Ethiopian flower exporters, it is crucial to understand that the European trade in flowers is characterised by different sales channels, each with its very own set of requirements. The level of demand for social and environmental standards differs significantly between the florist channel and the supermarket channel. The different characteristics and governance structures of the two channels have influenced the types of standards that are applied in each.

The traditional florist channel still dominates the retail distribution of flowers in most European countries. Many products which pass through the auction system end up in this channel. When selling products via the auction system, it is good to know that three standards are identified on the auction clock front: MPS-ABC, Florimark Production and Fair Flowers Fair Plants (FFP). In case of FFP, for instance, the FFP grower is indicated with an ‘F’ on the auction clock. The 'F' is also printed on the electronic clock transactions (EKT's).

Still, participation in MPS-ABC or in any other certification scheme is not a mandatory requirement for supplying flowers to the auctions. Furthermore, only a small number of the wholesalers who buy on the auction clock pass the information about certification on to their customers. So, no real market pressure exists to adopting standards.

Nonetheless, a vast majority of auction suppliers adheres to one or more standards with MPS-ABC being by far the most popular standard. Estimates suggest that about 80% of flowers supplied to the auctions is produced by a grower who participates in the MPS-ABC scheme. Many producers consider obtaining MPS environmental certification a good way to enhance the farm’s reputation.

Exporters supplying the florist channel, directly or via the auction, have the opportunity to differentiate themselves with FFP and FLP certificates, which is communicated all the way to the end-consumers.

The lion’s share of certified flowers, however, are sold in supermarkets and other types of retail chains. The importance of this channel has been growing for a number of years, but is now stabilising in most countries. In the supermarket channel, Fairtrade has created a considerable market niche. Furthermore, large retailers increasingly require compliance with standards such as GLOBALGAP and ETI to ensure themselves of the quality of their suppliers’ products and services and to reduce risks with respect to ethical aspects of production. In the supermarket channel, social and environmental certificates have become a true ‘license to export’.

Consequently, for Ethiopian growers, the selection of which standards to adopt has become a critical part of the development of a sound export strategy. A producer needs to determine not only his target market and sales channel, but also specific demands and relevance of each standard in those sales channels. A grower should also consider if participation in certification schemes can assist his company in building a more efficient and professional organisation and enhance the farm’s reputation.

Still, in these economically challenging times, costs of yet another standard can weigh heavy on the company’s finances. In the end, each farm needs to evaluate which combination of certification schemes offers best value and fits their buyer portfolio and overall company strategy.

Table 12.2: Aspects covered by standard (alfabetically sorted)

	Aspect covered		
	Social	**Environ mental**	**Quality**
Consumer labels			
EU Ecolabel / national ecolabels (Milieukeur)		■■■■	
EKO		■■■■	
Fair Flowers Fair Plants (FFP)	■■■■	■■■	■
Fairtrade Labelling Organization (FLO), Max Havelaar	■■■■	■■	
Flower Label Programme (FLP)	■■■■	■	
Rainforest Alliance - Flowers and Ferns	■■	■■■■	
B2B standards			
Ethical Trade Initiative (ETI)	■■■■		
GLOBALGAP		■■■	■
ISO 14001		■■■■	■■
MPS family: MPS-ABC		■■■■	■
MPS family: MPS-SQ	■■■■		
MPS family: MPS-GAP	■■	■■■■	■
MPS family: MPS-Florimark	■■■■	■■■■	■■■■
SA8000	■■■■		
Developing country initiatives			
EHPEA Code of Practice	■	■■■	■

Source: BTC, ProVerde (2010)

12.4.1 EHPEA Code of Practice for sustainable flower production

The EHPEA Code of Practice for Sustainable Flower Production is the result of an initiative to introduce a voluntary system of continuous professional and technical development, monitoring and self regulation into the flower sector, with considerations for:

- The industries own need and responsibility to implement sustainable practices, provide suitable facilities and safe working conditions, and to safeguard the local environment
- The need to remain competitive and to protect and enhance the reputation of the Ethiopian flower sector in the international market place
- The concerns of Ethiopian society and the international market place about the implementation of Good Agricultural Practices, protection of the environment and the welfare of employees

The code has been developed by a team comprising EHPEA members and local stakeholders and the development has been guided by external expertise provided through the Ethiopia Netherlands Horticulture Partnership Programme. Since the launch of the Code, EHPEA's training team has been proactive in helping farms to meet the requirements of the Code.

ⓘ Objectives of the EHPEA Code

- Long-term economic viability of the sector
- Implementation of sustainable working practices and procedures
- Development of skills at all levels of employment
- Enhancement of safe working practices to maintain the well being of the workforce
- Responsible management of activities that affect the environment
- Implementation of at least the minimum labour conditions in accordance with the National Law and promotion of healthy industrial relations
- Active contribution to the community in which we oeprater
- Enhancement of consumer health and safety

Bronze, Silver and Gold level

The Code of Practice is designed to have three levels of requirements, Bronze, Silver and Gold. In 2007, only the bronze level was launched as it was judged that emphasis should be placed on getting all farms in the sector to meet a good basic standard. At this bronze level, the Code defines the minimum acceptable standards for operation of an export flower or ornamental farm in Ethiopia. The Code has now been widely adopted in Ethiopian horticulture. Most flower farms in Ethiopia comply with its basic requirements for sustainable farming and have thereby reached the Bronze level status. Additionally, two higher standards are defined within the Code of Practice: Silver Level and Gold Level. Farmers are encouraged to progress to these levels.

The Silver Level sets internationally recognised standards for Good Agricultural Practices, protection of the environment and responsible employment practices and includes requirements of equivalent content and standard to the international market labels that are widely used in the sector.
The Gold level sets higher standards and challenges to farm. At this level the farm will need to become involved in Corporate Social Responsibility, environmental consideration, product quality management and sector development through involvement in industry development activities and management capacity building.

13 Post Harvest

13.1 Introduction

Post harvest activities determine for a larger part the condition and quality of the roses in which they reach the customer. Even if everything goes well during the cultivation process, with a high quality product as a result, still the product delivered to the customer can be of poor quality when the post harvest process is poorly managed.

13.2 Harvesting

Correct harvesting is the first stage of assuring that high quality flowers are delivered to the market. This includes harvesting the right lengths, cutting at the right position on the bush, making clean cuts (to prevent dieback), general bush management (i.e. leaving sufficient foliage on the bush, generation of growing points), but also cutting at the right cut stage and careful handling during harvesting and transport to prevent damage to the flowers.

13.2.1 Cut stage

The cut stage of a rose is related to the opening stage of the flower. Each variety has its own opening characteristics and rates. Apparent small differences in opening stage at harvest can mean large differences in flower quality when delivered to the market. Therefore, identifying the correct opening stage of the flower for harvest is essential and needs training, practice and experience. Supervisors and harvesters should be trained and updated regularly to be familiar with the opening characteristics of the varieties grown on the farm.

To get a high quality mark at the market, it is also important that roses are delivered to the market in uniformity of cut stage. Flowers will be judged on the uniformity of cut stage in all of the bunches of a sales batch and not bunch to bunch. Delivering uniform harvested batches to the pack house will save time in the grading and packing process. Good and regular feedback from the un-packers and / or buyers on the opening stage of the flowers, gives you the opportunity to promptly react if opening stage deviates from what is desired and establishes good working relations with your customers and trust for being a reliable supplier. Different buyers have different preferences or requirements regarding cut stage and are prepared to pay for batches with required or desired and uniform cut stage.

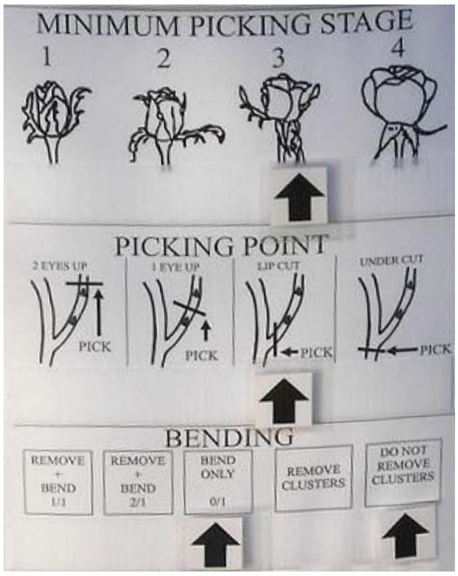


Figure 13.1: Example of harvest instructions in the greenhouse

In the greenhouse, instruct and communicate to your employees the cut stage / range to be harvested and monitor to see if the instructions are understood and followed. For example, this can be done by illustrations of the proper harvest stage and technique (see figure 13.1). Good supervision during cutting activities is very important and mistakes should be corrected immediately upon detection.

13.2.2 Handling

Any damage to roses that occurs during handling on the farm produces no or hardly any symptoms and will only become clear until the roses reach the market. Therefore employees are not always aware of the importance to carefully handle the roses during post harvest activities. To make your employees aware of the effects of damage to roses during the post harvest process, explain and show them the effects of physical damage to the final market quality of the product. Damaged flowers are also more sensitive to infection by botrytis. Some examples of physical damage to roses during handling are (see figures 13.2 – 13.7):

- *Thorn pricks and torn petals:* These occur mostly during harvest when long and short stems are placed together. Damage can also occur when the flowers are put into and taken out of the buckets.

Care is also needed during de-foliating. Stems must not be separated by dragging them from the bucket or pile on the table

- *Tip damage to the petals:* Hitting the rose buds on the top of the door frame or on the trolleys and shelves are very common causes of tip damage to the petals. Damage also occurs during export when the cardboard head wrap is not placed correctly, bunches are placed too close to the end of a box and / or the bunches are not well secured in the boxes.
- *Pressure damage:* Pressure damage can occure by touching and squeezing the buds during grading and bunching. Other causes are too tight cardboard head wrapping or to many bunches packed in a box.
- *Peeling:* Peeling of the outer petals is a practice that is sometimes done to remove botrytis spots or to make the flower look less open. However, these are not good practices, while removing pentals damages the flower and creates wounds, which again can be infected by botrytis.
- *Flat buds:* Flat buds are a common problem when too many bunches are packed in a box. Although packing as much bunches in a box seems economically efficient, overpacking actuallly will result in lower quality marks or rejected batches.
- *Neck damage:* Neck damage can occure, when a hanging grader is used. Make sure the hanging grader is clean and cannot damage the flower stem and neck.

		
Figure 13.2: Thorn petals	**Figure 13.3:** Damaged petals	**Figure 13.4:** Pressure damage
		
Figure 13.5: Peeling wound	**Figure 13.6:** Flat buds	**Figure 13.7:** Neck damage

Transport to the pack house

During transport from the greenhouse to the pack house, the flower should be handled with care to prevent damage and dehydration. Damage may occur when, e.g workers bend over the flowers to pick up buckets, flowers hit the trolley structure during loading or transport or hit walls or door frames, buckets are too close together on the trolley. Dehydration may occur when, e.g. flowers stay too long in the greenhouse before transported to the pack house, flowers are not shaded from the sun while waiting to be transported to the greenhouse, transport time from greenhouse to pack house is too long. During the rainy season, special attention should be given to the possibility of effection by botrytis. The most important thing is to keep the flowers dry and protect them against the rain during transport.

13.2.3 Prevention of botrytis

Botrytis infection is the most common cause of reducing marketable quality and value of roses after harvest. Symptoms will hardly show when roses are shipped and will mostly only become clear until the roses reach the market (botrytis spots on petals, or rotten petals, see figure 13.9 and 13.10). It is therefore important to prevent infection prior to shipment. Problems are particularly severe during the rainy season, as botrytis favours rainy, moist and high humidity climatic conditions.

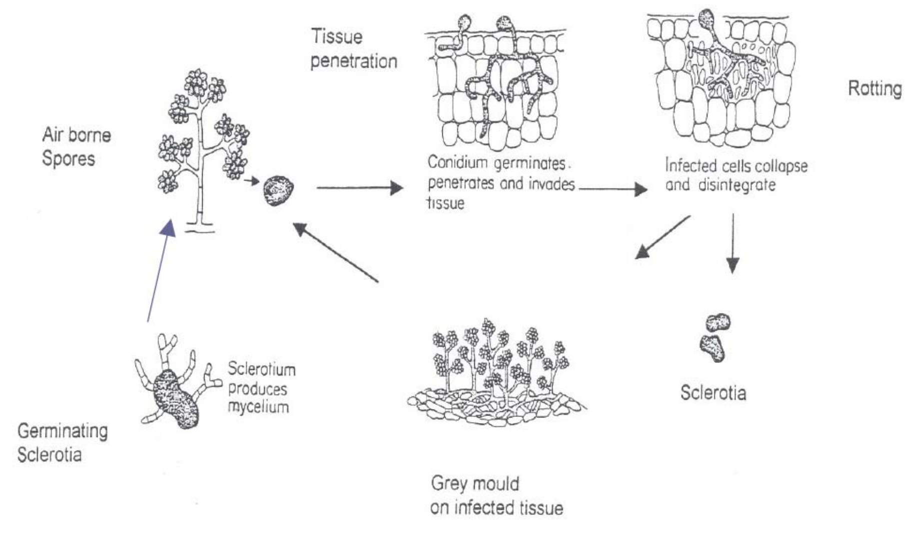


Figure 13.8: Botrytis life cycle

Figure 13.9: Botrytis spotting

Figure 13.10: Petal rot

Botrytis is spread primarily by air blown spores and can be found everywhere in small numbers. Numbers increase when dead or infected plant materials are not removed from the greenhouse. Keeping the greenhouse clean of crop debris is important for preventing botrytis infections. Infected plant material should be burned and composting of crop debris should be done down wind of the greenhouse to prevent spores being blown back to the production area.
Furthermore, high humidity and open wounds on the plant or harvested flower create ideal conditions for infection. Therefore, good ventilation practices, selective pruning of overcrowded plant material and prevention of crop and flower damage should be followed. After harvest, less favourable botrytis conditions should be maintained (cold and dry), so a continuous cold chain is important. Fluctuations in temperature during the cold chain will create condensation and should therefore be avoided.

13.3 Bucket and post harvest solution management

Prevention of dehydration and promotion of water uptake are both important issues that affect bud opening and determine vase life of roses. Bacteria growing in the post harvest water can block the xylem vessels of the flower stem and impede water uptake, resulting in a reduction of vase life. Therefore adequate hygiene measures should be implemented to keep bacterial growth to a minimum. This includes proper bucket management and use of post harvest solutions.

13.3.1 Bucket hygiene and use

Firstly, use different buckets for the green house and for the pack house and keep them separate. Greenhouse buckets will get dirtier and are harder to clean thoroughly. However, the flowers will only stay in the greenhouse buckets for a relatively short time. Pack house buckets are used for a

prolonged time and should be cleaner to reduce the risk of bacterial problems to the minimum. Use different colours or types to differentiate between greenhouse and pack house buckets. Buckets should have the right height and diameter (that fit your roses and a standard number of bunches), are made of durable material and preferably light coloured (easy to see if they are clean).
When cleaning the buckets, wash with a detergent and scrub the surface thoroughly (inside and outside). Then soak in disinfection water (chlorine) for at least an hour. Stack the buckets upside down in an open stack to drain dry (see figure 13.11). Close stacking (one bucket inside the other) of wet buckets should be avoided, as it encourages bacteria growth (see figure 13.12).

Figure 13.11: Good practice: open bucket stacking

Figure 13.12: Poor practice: close bucket stacking

13.3.2 Post harvest solution

Water uptake by a harvested flower is interrupted when flowers are left out of the water. If this is for a longer period, the ends of the xylem vessels in the rose stem dry out and air is drawn into the xylem vessels, creating an air embolism. Air embolism makes re-hydration and movement of water up the flower stem more difficult. To prevent embolism, make sure to put the flower stems in water immediately after harvest and are taken to the cold room within 30 minutes. Make sure that all stems are actually in the water. During post harvest handling, reduce the period that the flowers are out of the water and cold room to a minimum. The quality of the water is important as well. At a pH of 4 - 5 the flower stems take up water most easily. Furthermore, level of salts should be low and the water should be free of bacteria. Ideally disinfected water should be used for post harvest solutions (e.g. reverse osmosis) as bacteria grow on organic matter found in water.
Various post harvest chemicals can be added to the post harvest solution, to promote water uptake, provide nutrients and prevent ethylene inhibition (see table 13.1).

Table 13.1: Post harvest chemicals

Chemical	Use and remarks
Aluminium Sulphate	- Reduce pH - Precipitate dirt in the water - Rate to use: about 0.5 - 0.8 g/l
Chlorine	- Control bacteria - Add to water in the form of calcium hypochlorite (preferred), or sodium hypochlorite - Solutions containing chlorine are active for only a few hours, i.e. the chlorine will escape into the air as harmless chlorine gass - Chlorine is deactivated by organic matter in the water - Rate to use: 0.1 ppm of active chlorine
Citric Acid	- Reduce pH - Do not use in combination with chlorine, i.e. citric acid will inactivate chlorine - Rate of use: depends on pH of the water
Sugar	- Sugar acts as a nutrient for the harvested flowers - Because sugar will also feed the bacteria, it should not be used for roses
Silver Thiosulphate (STS)	- Ethylene inhibitor; will reduce ethylene synthesis - Ethylene causes senescence and premature aging and/or shorter vase life

Wetting Agent	- A non-ionic wetting agent reduces surface tension and therefore making it easier for water to enter and move in the xylem vessels - Example of a wetting agent: Agal

Beside the chemicals mentioned in table 13.1, there are also many proprietary mixes of post harvest chemicals available on the market (e.g. Chrysal, Florissant, Floralife, Flower Care). These serve the same basic functions, but are formulated and packed to facilitate accurate application and convenience.
Mix the post harvest chemicals on the day of use, stir the mixture thoroughly and check if all the chemicals have dissolved to ensure the effectiveness. It is best to use cold water, to faster cool the flowers in the cold room. Do not use too much post harvest solution per bucket, as it is a waste of chemicals and water. To determine the correct amount per bucket, check how much is left in the bucket after use. When mixing the solutions, keep in mind the safety measures (e.g. eye protection, gloves, storing chemicals), which are similar to those for crop protection chemicals (section 8.3.4 & 8.3.5).

13.4 Pack house

13.4.1 Defoliation

Leaves need to be removed from the lower part of the stem so that the leaves are not below the water in the buckets. This helps to prevent bacterial growth in the water and means that bunches will drain and dry faster before packaging. Packing wet flowers means a higher risk of the boxes collapsing and infection by botrytis. Furthermore, leaves contribute to weight and volume and thus to transport costs. Not too much leaves should be removed to ensure bunches remain well in the auction buckets and are still ranked with a high quality mark. In general leaves should be removed from 1/3 of the finished stem length, but specific costumer requirements may differ.
Different methods can be used to defoliate the stems, e.g. leaf forks, stem strippers, defoliating machine. During defoliating be careful not to excessively damage the stems, because this can encourage bacterial growth in the water.

13.4.2 Grading, bunching and trimming

Grading and bunching are important operations and require skilled employees. Incorrect grading and bunching can result in a non uniform product, damaged flowers and significant loss in quality and price at the market. Creation of a uniform and high quality product needs the employees to have good and mutual understanding of the standards. Flowers that are below standard must be rejected. Rejection of flowers is a difficult task for employees to get confidence in. Therefore extensive training of the employees, practice until the employees are comfortable with their task, common understanding within the team, and active supervision during the bunching process are essential.
During the grading and bunching process it is important to not damage the flowers, e.g. damage to neck from a hanging grader, bruising the flower buds when they hit the table or measuring board, or pressing or touching the flower buds. Make the employees understand that flowers handled in this way will show signs of physical damage when reaching the market / customer. A vase life trial can make them aware of the effect of physical damage due to wrong handling during grading and bunching.
Furthermore, your employees should thoroughly understand the length grading system. A colour based system (see figure 13.13), instead of a number based system (see figure 13.14), eases grading operations for the employees. During the trimming process, bunches are cut back to length based on the shortest stem in the bunch, so obvious short stems should be removed from the bunch to reduce the loss of potential length from the other stems in the bunch. Besides length, colour and cut stage should also be uniform per bunch.
Correct placement of the bunching paper is important during transport (see figures 13.15 - 13.17). Flowers that are placed too close to the edge of the bunching paper are likely to be damaged during transport. The tightness and position of the rubber band around the bunching paper should be as such that it holds the bunching paper in place. The rubber band holding the stems, should be tight enough

to hold the bunch together and should not be too low, as about 2cm will be trimmed off during unpacking.

Figure 13.13: Easy length grading with colour based system

Figure 13.14: Length grading with numbers

Figure 13.15: Good bunching practice

Figure 13.16: Bad bunching practice: don't touch or press the flowers buds during bunching

Figure 13.17: Good positioning of the bunching paper

13.4.3 Packing

Packing is an important final stage in the pack house: careful packing will help to preserve the quality of the work done in the pack house; poor packing will result in damaged flowers reaching the market.
In the choice of boxes make sure to choose good quality and strong boxes. Investing in high quality strong boxes prevents collapsing of boxes and thus damage to the flowers during transport. Large boxes are much more fragile than small boxes (preferred size: 100 x 33 x 21cm). Corner constructions of a box are important, as greatest contribution to compression strength comes from the box corners. Also make sure to place your orders in time to ensure that always enough boxes are available at the farm (preferable: stock for one month). Store the boxes in a clean and dry area (i.e. 23-27°C, RV 50%) to keep the strength of the cardboard.
Before packing the bunches, make sure there is enough time for the bunches to drain before packing, so the box does not get wet. Before packing the bunches, do a final check on the quality of the flowers and check if the bunching paper is still fixed in place. Two larger straps should be placed inside the box to prevent the flowers from moving during shipment. These should be tight enough to fix the bunches, but not so tight that the box tears and flowers are damaged. Two straps should be placed around the outside of the box, again not to loose and not too tight that it disfigures the box.
The pack rate of the boxes should be as such that the boxes are packed full, but not bulging. Over packing will result in damaged flowers (flat buds) and unstable stacking (the top of the box should be flat, the sides should be vertical and the corners should be square).
Each box should be clearly labelled, providing information on: farm name and produce of Ethiopia, variety, flower count and stem length and box number. Pre-printed farm labels can be used. If there is any quality problem and the box or batch needs to be sold as a separate lot, indicate this clearly on the box label and pack list.

13.5 Cold chain

It is important to maintain the cold chain before, during and after the packing process. Poor cold chain management is the most important cause of loss of quality. Flowers are a living product and produce heat by respiration. More heat is produced when the start temperature is high (see figure 13.18). A high temperature at packing and long periods in a dense stack of boxes both result in loss of quality due to heating. Typical problems that occur due to poor cold chain management include botrytis infection, open flowers, wilting flowers, bent stems, loss of vase life, and heat damaged flowers. The temperature settings that should be used during the different stages of the cold chain are displayed in table 13.2

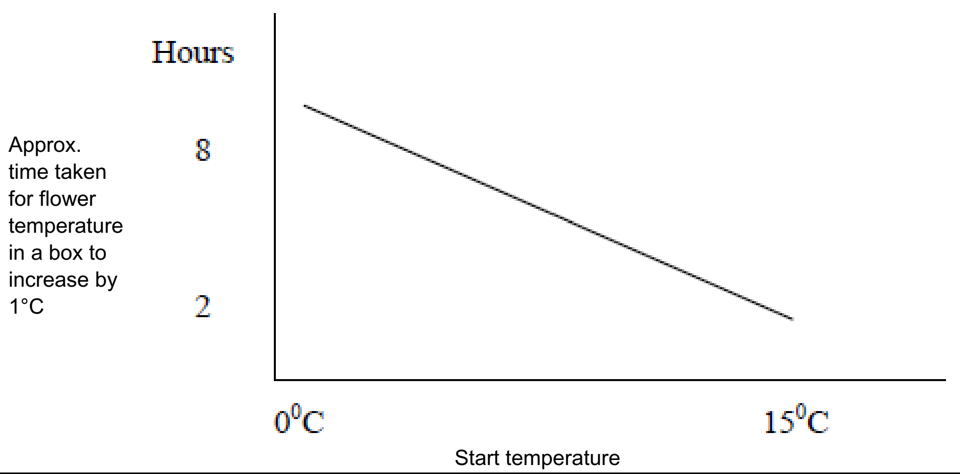


Figure 13.18: increase of temperature in flower box

Table 13.2: Required temperature for different areas

Area	Required temperature	Remark
Receiving cold room	5 - 8°C during the day 2 - 5°C overnight	- Facilitates re-hydration - Minimizes condensation when flowers enter grading hall - Minimum time in receiving cold room: 2 hours - Maximum time in receiving cold room: 24 hours
Grading hall	16 - 18°C	- Comfortable for workers - Will not harm flowers, if time in grading hall is less than 1 hour
Final cold room	2°C	- Ensures the flowers will not freeze
Cold truck	2 - 5°C	- Ensures the flowers will not freeze

Flowers are cooled by being in contact with cold air. In the cold room, cold air is blown from the cooling unit along the roof of the cold room until it hits the end wall, falls (cold air is denser than warm air) and returns to the cooling unit. This means that the air under the cooling unit is warmer and moving more slowly. In theory uniform temperature can be achieved throughout the whole cold room provided the door is kept closed and the room and contents have sufficient time to equilibrate. In practice most cold rooms have hot spots where there is poor air circulation and cold spots where the air from the cooling unit falls. Positioning of the flowers and shelving will also influence where the air moves freely and where these items act as obstacles. Shelves should be placed at right angles to the flow of cold air from the cooling unit and in a way so that the cold air is blown over the top of the room, hits the back wall and then passes freely through all the shelves and flowers or boxes.

Before packing the flowers are cooled by cold air passing over and around the buckets. A small space between buckets is desirable to facilitate air flow and buckets should be raised off the flower to ensure the whole bucket to cool. After packing heat is removed from the surface of the box that is exposed to the cold air of the cold room. After packing, open stacking of boxes is important, as boxes placed in a closed stack will only cool on the outside of the stack and boxes in the middle of the stack continue to produce heat (see figure 13.19).

It is important to measure the temperatures at several spots in the cold room to identify hot and cold areas and to adjust placement of flowers in the cold room to achieve quick cooling. Temperature measurements should be done at various times during the day and records should be kept of measurements done.

Figure 13.19: Loose stacking of boxes (left) or use of racks (right) allows more of the box surface to be exposed to cold air

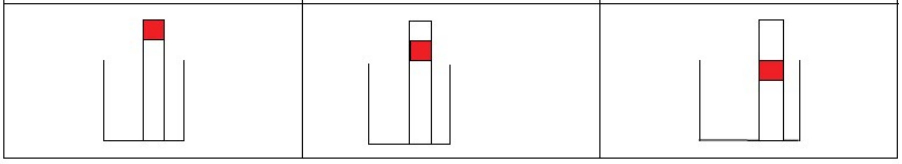
To evaluate the heat gained by flowers during transport, heat exposure can be measured using degree hours. Degree hours are calculated by multiplying the number of hours by the temperature difference between actual and desired. For roses the desired temperature is 0°C. For most rose varieties, loss of quality is visible after 700 Degree Hours. Monitoring of temperatures during transport will give insight in the actual Degree Hours so action can be taken when necessary.

13.5.1 Receiving cold room

After harvesting the flowers can be placed in a receiving cold room, which is used to remove field heat and to slow down the opening of the buds between harvesting and bunching. Temperatures for the receiving cold room are typically 5-8°C during the day and 2-5°C overnight. Some farms do not have a receiving cold room and in this case the flowers are graded and bunched straight from the greenhouse.

For intake of flowers in the receiving cold room a stock management system should be used, which means that flowers are clearly labelled on arrival at the receiving cold room and the flowers are processed on a first in first out basis, to ensure and keep quality of the product. Labels should include greenhouse number, date and day of harvest, and time of harvest during the day (i.e. 1^{st}, 2^{nd}, 3^{rd} harvest). A coloured based labelling system eases operations for the employees (see figure 13.20)

First Harvest Paint the tip	Second Harvest Paint the middle	Third harvest Paint the lower part



Colour Code System	
Day	
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

Monday First Harvest

Figure 13.20: Example of a coloured based labelling system for the receiving cold room

13.5.2 Final cold room

The cold chain to the market starts in the final cold room, where the required temperature for transport should be reached. The thermostat in the final cold room should be set to 2°C and temperature in the cold room should be measured and recorded regular if it is maintained. Opening of doors should be kept to a minimum. Shelves in the cold room should be arranged in such a way, that the cold air passes over the flowers. Therefore do not place shelves on the back and sidewalls.

Packing of the flowers is done inside the cold room. Make sure there is enough time for the flowers to cool before packing. Preferably, the flowers are bunched the day before packing, are packed in the morning and are delivered to the airport the same day. In this way, the flowers are cooled overnight and thus ensures the flowers are sufficient cold before they are packed. Cold air passing around the outside of boxes only cools the outside of the boxes and the flowers on the inside become hotter due to heat generated by respiration. Packing cold flowers will ensure that the rate of respiration and thus heat generated is kept to a minimum. Open stacking of boxes is important to allow better air circulation. When boxes are placed in close stacks, only the outside boxes of the stack will be cooled.

Furthermore, hygiene in the final cold room is important, to minimize botrytis infections. Therefore, do not keep infected rejects (i.e. for local sale) in the final cold room, never store bunched flowers for more than 2 days in the final cold room before shipment, and keep the floor of the final cold room dry and clean of debris.

13.5.3 Cold truck

Well organized cold transport to the airport is a crucial link in the cold chain, as all previous measures and efforts to keep the roses cold to maintain quality can be nullified during poor cold transport management. Typically the flower temperature increases by 2-5°C during this part of the cold chain due to reasons of not working or not correctly set cool unit, not properly cooled boxes before loading, incorrectly stacked load and thus poor air circulation in the truck, and incorrect handling by the truck driver. Some points of attention with regard to cold truck transport are:

- Cool the truck to 2°C before loading and keep records
- Measure and record the box temperature before loading (2°C is good, > 5°C is unacceptable)
- The pack house manager should be present when the truck is loaded, to ensure the loading is done fast, the boxes are handled carefully, and are stacked correctly for good air circulation

- Instruct the driver to drive straight to the airport and to make sure to keep the cooling unit running at all times. Furthermore, the driver should record and report back to the pack house manger departure time, arrival time, time of unloading, and box temperature at unloading

Glossary

Anion - Positively charged ion
Anoxia - Oxygen deficiency, occurs when a rooting medium (soil or substrate) contains too much water and to allow enough oxygen supply for the roots to function properly.
Apical dominance - the strongest contribution to correlative inhibition of growth is from the shoot apex (main flower bud and the youngest leaves).
Axillary bud - An unextended, partly developed bud, located in the axil of a leaf, formed by the apical meristem of each shoot. The axillary buds are the start for the above-ground parts of the rose bush.

Basal buds - These are buds leading to basal shoots or bottom breaks, and are already present in the scale-axils axillary buds in the scion used for vegetative propagation.
Basal shoots, ground shoots or bottom breaks - Strongly growing shoots developing at the base of the primary shoot. These shoots form the frame of a rose plant.
Bending - Bending of thin, short or unmarketable stems to increase the Leaf Area Index (LAI) and a way to renew the old leave stock
Blind shoot - A blind shoot is a fully grown shoot that fails to produce a flower; instead of a flower bud at the end, there is a group of small leaves.

Casparian strip - A band of cell wall material deposited on the radial and transverse walls of the endodermis, which is chemically different from the rest of the cell wall. It blocks the passive flow of materials, such as water and solutes into the vascular tissues of the plant.
Cation - Negatively charged ion
Correlative inhibition - Differences in the ability of different axillary buds to sprout in relation to their distance from the apex. Correlative inhibited buds are not “dormant” as they show growth although barely perceptible.
Cutting - Producing cuttings is a vegetative propagation technique, by which a piece of a source plant (containing at least one leaf and a dormant bud) is placed in a suitable medium to stimulate rooting and growth of a new stem

Desuckering - Desuckering is a technique with which the small side branches (suckers) are carefully removed from the rose stem
Disbudding - Disbudding is a pruning technique, by which the flower is removed from (unmarketable) stems
Dry matter partition - The allocation of assimilates (dry matter production) to the flowering shoots or to carbohydrate storage in woody parts of the plant.

Flush cropping - Flush cropping implies a cropping strategy with harvest and production peaks and periods of low production in consecutive periods.

Hydroponics - Cultivation in a nutrient solution without other soil or substrate than the one used for the propagation of the material. However, the term “hydroponic” is often used to indicate “substrate cultivation”.

Inert substrate - a substrate which has no influence on the root environment from a chemical point of view.
Ion - Atom or molecule in which the total number of electrons is not equal to the total number of protons, giving it an electrical charge.

Leaf Area Index (LAI) - The Leaf Area Index is the ratio of total upper leaf surface divided by the ground surface area. LAI is used to predict the photosynthetic primary production; the optimal value lays between 3-4
Light conversion efficiency: The efficiency with which the crop uses the available light to produce dry matter.

Phloem vessels - The type of transport tissue that carries organic nutrients made during photosynthesis (and known as photosynthates) to all parts of the plant where needed.
Pinching - Pinching is a pruning technique, by which the tip of a growing stem is removed and apical dominance is broken; pinching is removal of the growing point before flowers can develop
Ploidy - (diploid, tetraploid, pentaploid, hexaploid)
Primary shoot - The first shoot developed after vegetative propagation from an axillary bud in the scion. In cultivation using the bending method, this shoot is bent to stimulate the outgrowth of basal shoots.

Root pressure - If water can move by osmosis into the root from the soil causes a positive pressure that forces sap up the xylem towards the leaves. Root pressure is highest in the morning before the stomata open and allow transpiration to begin.

Sink - Location in the rose plant where assimilates are produced (green leaves)
Source - Location in the rose plant where assimilates are transported to (growing points)
Staggered cropping - Staggered cropping implies a cropping strategy for continuous production of stems and maintaining a constant uptake of light, water and nutrients by the crop.
Spray roses - A flower stem with at least three flower buds is called a spray
Stentling - Stenting is a vegetative propagation technique, by which a cutting (scion) is grafted on a single internode of a non-rooted adventitious rootstock; cutting and grafting is performed in one action
Substrate - a growing medium different from soil in the place where it was originally.
Sweethearts - A one flower per stem rose variety with a flower diameter <9 cm (measured in an angle of 45 degrees from the flower base). Sweet hearts between 8 and 9 cm flower diameter can be categorized as hybrid tea roses if in the production phase the average length of the stem is around 90 cm.

Tea-hybrid - A one flower per stem rose variety with a flower diameter >9 cm (measured in an angle of 45 degrees from the flower base). He has to offer the VKC roses again which are at least 90 cm. Another possibility is that the breeder indicates that the flower diameter at complete opening is at least 10 cm. Also in that case the breeder has to offer the VKC roses again which are completely opened and have a diameter of at least 10 cm. For the intermediate types no standardisation has been agreed upon. The problem is that in this group two limits (upper and lower limit) have to be determined and checked.
Thalamums - flower base
Top graft - Top grafting is a vegetative propagation technique, by which a cutting (scion) is grafted onto suitable rootstock (plant stumb, which already has an established and healthy root system)
Transpirational pull - The most important cause of xylem sap flow is the evaporation of water from certain areal plant parts to the atmosphere. This transpiration causes a negative pressure or tension in the xylem that pulls the water from the roots and soil.

Xylem vessels - One of the two types of transport tissue in vascular plants. Its basic function is to transport water and some minerals through the plant.

Annex

Annex 1: Zero assessment

Farm Specifics
Production Area [ha] ....
Elevation [m] ....

1 Organisational Structure: — Responsible Employee
Farm Manager: ....
Production Manager: ....
Ass. Production Manager: ....
Grading Manager: ....
Greenhouse Supervisor/Headman: ....
Head of Fertigation: ....
Head of Crop Protection: ....

2 Staff details: — No. of employees
Greenhouse/Production: ....
Irrigation: ....
Crop-protection: ....
Maintenance: ....
Grading: ....
Construction: ....
Security: ....
Other supporting staff: ....
Total ....
Average No. of employees per ha.: ....

3 Greenhouse data:
Greenhouse brand: ....
Type of top-vent: ....
Side ventilation: ....
Age: ....
No. of Greenhouses ....
Bay Width: ....
Greenhouse size(s) [ha]: ....
Greenhouse width: ....
Type of GH-film: ....
Age: ....
Status: ....
Type of Shading: ....
What is max. slope in greenhouses ....
Maximum pump height to highest GH. ....

	20%				100%
Condition of the Greenhouse:					
Condition of the Greenhouse Film:					

4 Irrigation Equipment data:
Pump station:
No. and Type of pump(s): ....
Pump capacity: (m3/hr) ....
Irrigation capacity: (m3/hr) ....
Filtertype(s) ....
Size of mainline(s): (mm) ....

	20%				100%
Condition of the Pump unit:					

Fertigation:
Make of fertigation unit: ....
Type of fertigation unit: ....
Capacity of fert. Unit: (m3/hr.) ....
EC-control Yes/No: ....
pH-control Yes/No: ....
Last calibration check: ....
No. of fert. tanks (A, B, C etc.) ....
Capacity of fert. tanks: ....
Fertilization mixing procedure: ....

	20%				100%
Condition of the Fertigation unit:					

In-field equipment:
Irrigation distribution per valve [m2]: ....
Size of sub-main of valves [mm]: ....
Valve operation (elect./hydro.): ....
No. of beds per valve: ....
Bed length(s): ....
No. of driplines per bed: ....
Drip-spacing [cm]: ....
Drip-discharge [l/hr]: ....
Discharge per valve(s): ....

	20%				100%
Condition of the in-field equipment					
Condition of the driplines:					

5 Water source(s):
River pump capacity [m3/hr]: ....
Borehole pump capacity [m3/hr]: ....
Storage and capacity: ....
Analyses and date of source water: ....
EC of source water and yearly range: ....
pH of source water and yearly range: ....
Pre-filtration: ....
Rainwater collection: ....

6 Soil & water analysis history:
Regularity of soil/drainwater samples: ....
Last date of soil/drainwater results: ....
Procedure of sample taking: ....
Analyses done by: ....
Last 12 mths results available: ....

7 Feed and drain water data:
Frequency feed water checks: ....
Frequency drain/pit water checks: ....
Results EC/pH/other: ....
No. of irrigation rounds per day: ....
Irrigation volume per round: ....
Current fertigation regime: ....
Fertigation history last 12 mths: ....
Start time of irrigation: ....
Stop time of irrigation: ....

8 Crop-protection Equipment:
Type of spray system; ....
Make and type of spray unit: ....
Capacity of spray unit [l/hr]: ....
Working pressure of spray system: ....
No. of tanks and capacity: ....
Outlets per ha: ....
no. of spray lances: ....
no. of caps per lance: ....
Discharge per cap (type/color): ....
Calibration of spray caps: ....

	20%				100%
Condition of the spray pump:					
Condition of the spray equipment:					

9 Crop-protection History:
Pest & Disease History last 3 mths: ....
Spray History last 3 mths: ....
Chemical preparation procedure: ....
Spray procedures: (demo) ....
Spray times: ....
Scouting procedure: ....
Scouting History: ....
IPM Yes or No: ....

10 Sprayteam outfit & knowledge:
Workers awareness of procedures: ....
Frequency of replacement of mask filters: ....

	20%				100%
Condition of the spray uniforms:					
Condition of the spray masks:					
Conditions of the boots:					
Condition of the chemical store :					

11 Crop data (summarized):

	Varieties:	Ha.	Plant Date:	Breeder:
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
	Total:	ha.		

12 Climate data:
Data available: ....
Procedure and intervals: ....
(temp, humidity, rainfall, radiation) ....

13 Buildings and infra-structure:

	20%				100%
Condition of the roads and infrastructure					
Condition of the offices					
Condition of the stores					
Condition of the Internal transport					

14 Grading:
Hygiene protocol: ....
Post harvest treatments: ....
Grading procedures: ....
Export and rejects registration: ....
Handling time from crop to coldstore ....
No. of hours precooling before shipment ....

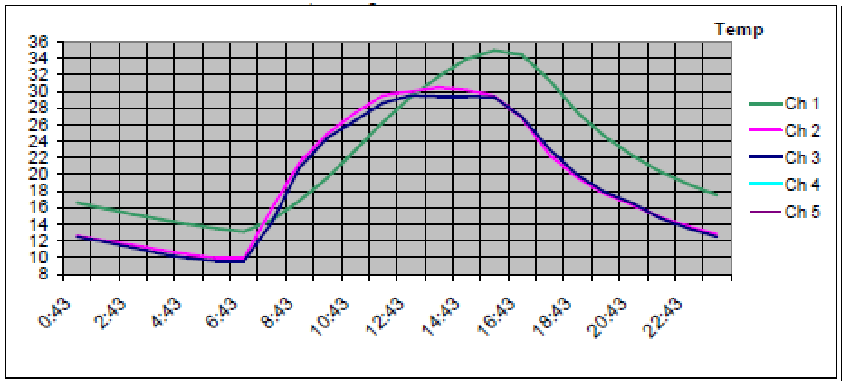
	20%				100%
Condition of the coldstore:					
Condition of the grading hall equipment					
Condition of the packing equipment:					

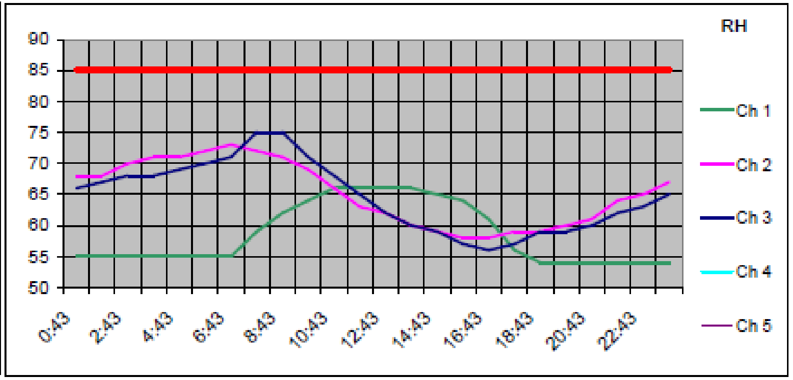
15 Stocks
Fertilizer stock registration: ....
Stock level fertilizers sufficient: ....
Crop protection stock registration: ....
Stock level chemicals sufficient: ....

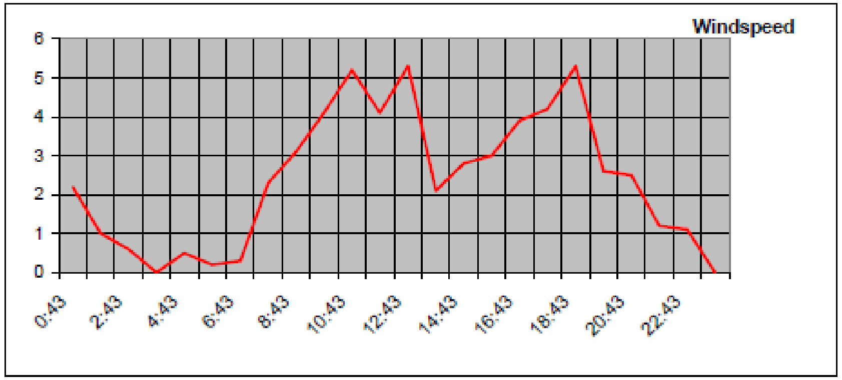
Annex 2: Benchmark rose farm Ethiopia

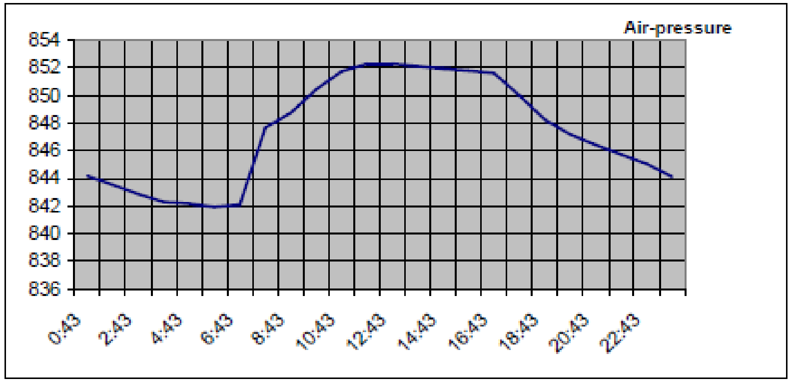
	International standard	Country best experience	Adopted standard	Farm
Market				
# of shipments per week	5	5	5	
# of days on the auction	5	5	5	
Average price on the auction	>	>	>	
Minimum volume per variety in ha.	2	2	3	
Constant quality and volume on the market?	yes	yes	yes	
Irrigation/Fertigation				
Budget in Birr/m2/year	30	20	25	
Input fertilizer ok? (on time)	yes	yes	yes	
Is fertigation unit working correct (EC/pH/Flow)? (setpoint fert. unit/drip EC has to be the same)	yes	yes	yes	
Portable EC/pH sensors working and calibrated?	yes	yes	yes	
Buffer solution available? (EC 4/pH 4 and 7)?	yes	yes	yes	
Optimum drip EC (Soil 1,2-1,4, hydroponics 1,5-1,8)	1,2	1,2-1,4	1,2	
Optimum drain % (between 20% and 40%)	30	30	30	
Measuring drip discharge and is it OK? (Flow and drip dis charge has to be the same)	yes	yes	yes	
Measuring soil EC/pH once a week? (optimum soil EC 0,5-0,9 measured with 1.2.2. volume extract, optimum drain EC 0,2-0,4 higher than drip EC)	yes	yes	yes	
Soil analyse once per 3 months? (optimum results see target Soil analyse)	yes	yes	yes	
Crop protection				
Budget chemicals in Birr/m2/year	25	20	20	
input chemicals ok? (on time)	yes	yes	yes	
Spraytimes/temp. below 27^{0}C	yes	yes	yes	
Nozzles changed/calibrated every month?	yes	yes	yes	
pH spray liquid 5.5?	yes	yes	yes	
Spare spray unit available?	yes	yes	yes	
Scout reports available?	yes	yes	yes	
Spray history available?	yes	yes	yes	
Level of spider mites	low	low	low	
Level of powdery	low	low	low	
Level of aphids	low	low	low	
Level of thrips	low	low	low	
Level of downy	low	low	low	
Production and bush management				
Registration production stems/m2/week	yes	yes	yes	
Registration rejects in %/week	yes	yes	yes	
% rejects	< 5	<5	<5	
Registration stem weight/length/week	yes	yes	yes	
Level of bend stock	good	good	good	
Harvesting shortly above the eye/leave (max 1/2 cm)	yes	yes	yes	
Crop staggered?	yes	yes	yes	
Cool chain management				
Minumum vaselife in days (at the unpacker)	7	7	7	
Optimum packed box temp. at the farm in ^{0}C	2 till 3	2 till 3	2 till 3	
Optimum packed box temp. at the unpacker in ^{0}C	15	15	15	
Minimum time in hours pre cooling at 4 ^{0}C	4	4	4	
Minimum temperature final cold room in ^{0}C	2	2	2	
Logging temperature for 24hrs inside coldstore	yes	yes	yes	
0% of Botrytis during test on farm (plastic bags over the heads)	yes	yes	yes	
Post harvest management				
Damage of leaves & flowerparts	good	good	good	
Bent stems	good	good	good	
Uniformity	good	good	good	
Cut stage	good	good	good	
Residue on leaves & flower parts	good	good	good	
Symptons of disease on leaves and flower parts	good	good	good	
Leveling of flowers in a bunch	good	good	good	
Management & Communication				
Level of management (qualified)	good	good	good	
# of employees per hectare	10	20	21	
Code of pratice (bronze/silver/gold)	bronze	bronze	bronze	
Proper computer on farm?	yes	yes	yes	
Proper internet on farm?	yes	yes	yes	
Market feedback from unpacker in days / week	4	4	4	

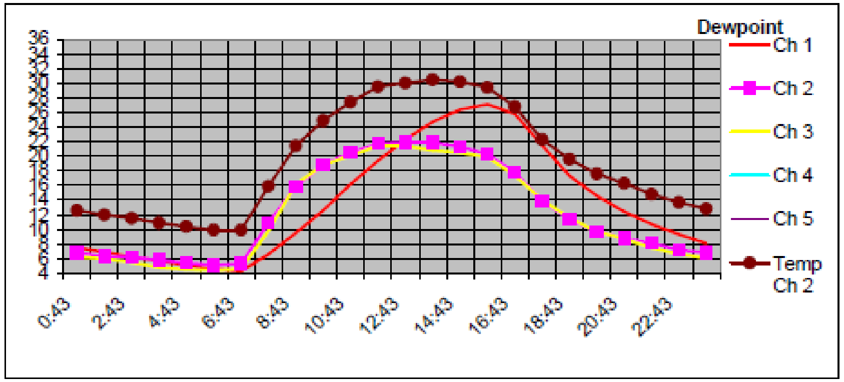
Annex 3: Climate graphics





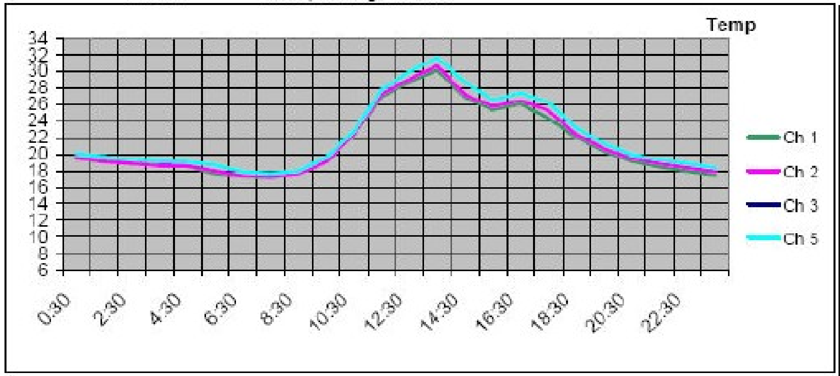


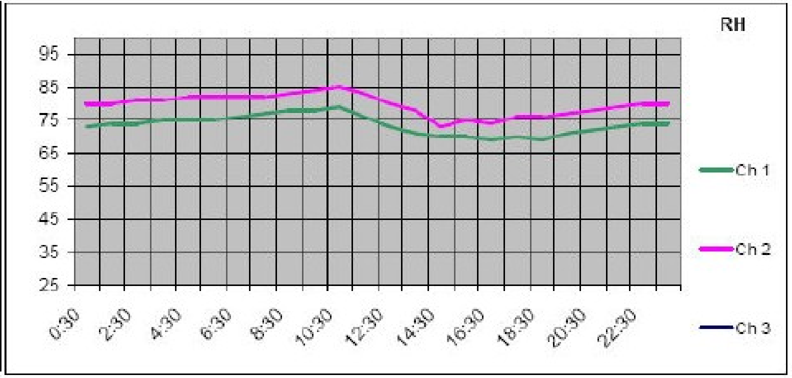


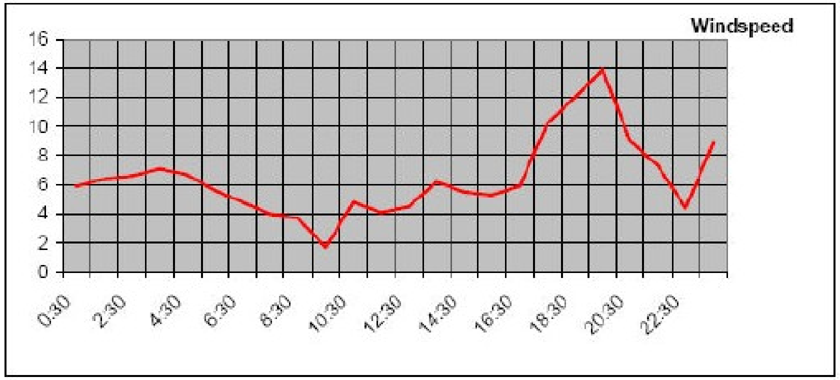


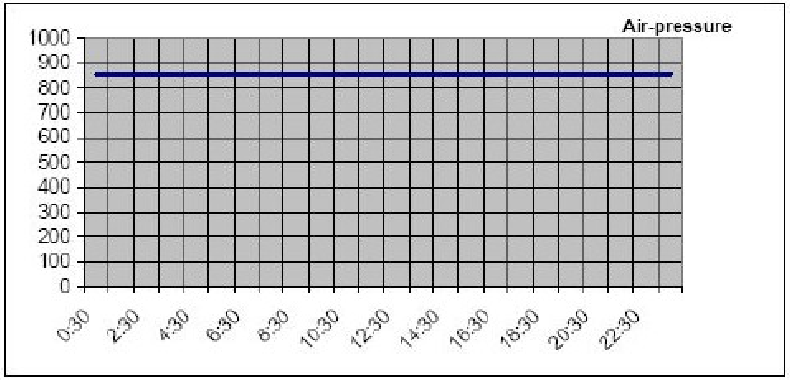
Lowest	temp	13,1	Lowest	RH	54%	CH 1
Highest	temp	34,9	Highest	RH	66%	CH 1
Average	temp	22,1	Average	RH	59%	CH 1
Lowest	temp	9,9	Lowest	RH	58%	CH 2
Highest	temp	30,5	Highest	RH	73%	CH 2
Average	temp	19,2	Average	RH	65%	CH 2
Lowest	temp	9,6	Lowest	RH	56%	CH 3
Highest	temp	29,5	Highest	RH	75%	CH 3
Average	temp	18,8	Average	RH	65%	CH 3
Lowest	temp		Lowest	RH		CH 4
Highest	temp		Highest	RH		CH 4
Average	temp		Average	RH		CH 4

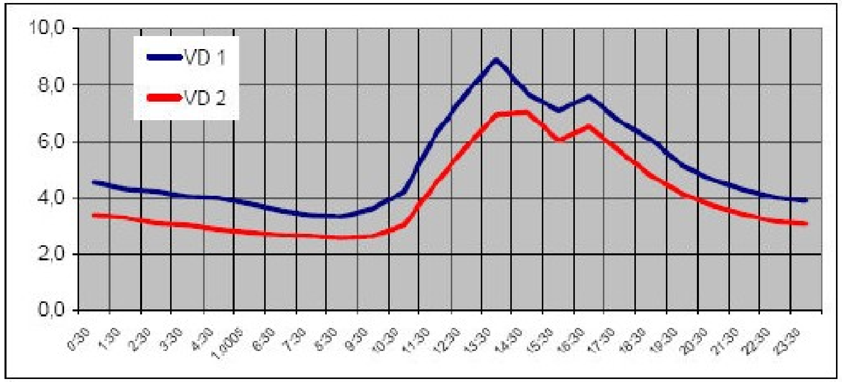
temp etm	21,5 (etmaal gemiddelde)	Wind speed (average)	6,4 m/sec	VD T T	634	Risk of Downey is moderate
rv 24 h	80% (etmaal gemiddelde					











Lowest	temp	17,2	Lowest	RH	69%	CH 1
Highest	temp	30,2	Highest	RH	79%	CH 1
Average	temp	21,3	Average	RH	74%	CH 1
Lowest	temp	17,2	Lowest	RH	73%	CH 2
Highest	temp	30,7	Highest	RH	85%	CH 2
Average	temp	21,5	Average	RH	80%	CH 2
Lowest	temp		Lowest	RH		CH 3
Highest	temp		Highest	RH		CH 3
Average	temp		Average	RH		CH 3
Lowest	temp		Lowest	RH		CH 4
Highest	temp		Highest	RH		CH 4
Average	temp		Average	RH		CH 4

Annex 4: Spurway soil analysis

CERTIFICATE OF ANALYSIS
SPURWAY GLASTUINBOUW (VOLLEGROND)

altic goed onderzoek loont

SAMPLE and EXAMINATION **HORTICOOP U.A.**

Laboratory code	: 9746	Sampling by	: Customer
Date received	: 17 november 2011	Sampling date	: Unknown
Date report	: 17 november 2011	Sample depth	: 25 cm
Sample received as	:		
Crop (cultivated)	: Rose (glasshouse)		

ANALYTICAL RESULTS **INTERPRETATION**

Parameter		Units	Test result in 10 cm	Target Range in 10 cm	
Nitrate-nitrogen	NO_3-N	kg/ha	52.6	60 - 80	quite low
Ammonium-nitrogen	NH_4-N	kg/ha	< 5.0	< 1	good
Phosphorus	P	kg/ha	425	30 - 50	very high
Potassium	K	kg/ha	644	250 - 350	high
Magnesium	Mg	kg/ha	326	200 - 300	quite high
Sulphur	S	kg/ha	65.3	50 - 100	vast sufficient
Calcium	Ca	kg/ha	839	600 - 2200	sufficient
Manganese	Mn	kg/ha	< 0.1	1 - 3	very low
Zinc	Zn	kg/ha	19.5	1 - 30	good
Iron	Fe	kg/ha	92.0	25 - 200	vast sufficient
Boron	B	kg/ha	1.2	0.3 - 0.9	quite high
Copper	Cu	kg/ha	6.1	2 - 6	quite high
Molybdenum	Mo	kg/ha	2.3	-	low
Sodium	Na	kg/ha	164	< 100	high
Chlorine	Cl	kg/ha	41.9	< 100	good
Silicon	Si	kg/ha	111	-	low
Conductivity	EC	mS/cm	1.9	< 3	good
Acidity (1:2)	pH-KCl		6.3	5.2 - 7.5	vast sufficient
Acidity	pH-H_2O		7.6	5.2 - 7.5	quite high

The interpretation is not crop dependent, more information concerning the interpretation and advisement can be found on page two of this certificate.

APPLIED METHODS

Parameter		Applied standard(s) or guideline	
		Pretreatment	**Measurement**
Nitrate-nitogen	NO_3-N	In-house method; Extraction	Equivalent to NEN-EN-ISO 13395
Ammonium-nitrogen	NH_4-N	In-house method; Extraction	Equivalent to NEN-EN-ISO 11732
Chlorine	Cl	In-house method; Extraction	Equivalent to NEN 6651
Other nutrients		In-house method; Extraction	Equivalent to NEN 6966
Boron (B), calcium (Ca), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), phosphorus (P), sulphur (S), silicon (Si), zinc (Zn)			
Acidity	pH-KCl	Equivalent to NEN 5750	Equivalent to NEN 5750
	pH-H_2O	Equivalent to NEN 5750	Equivalent to NEN 5750
Conductivity	EC	Equivalent to NEN 5749	Equivalent to NEN 5749

NUTRIENT STOCK AND INTERPRETATION

	Beschikbare voorraad	Adviesgift (in kg/ha)
Nitrogen	132 kg/ha	-
No fertilizer guidelines are available for subgroups of crop. Therefore, you are advised to contact your local agricultural specialist to discuss specific fertilizer recommendations.		
Phosphorus	2433 kg/ha	-
No fertilizer guidelines are available for subgroups of crop. Therefore, you are advised to contact your local agricultural specialist to discuss specific fertilizer recommendations.		
Potassium	1941 kg/ha	-
No fertilizer guidelines are available for subgroups of crop. Therefore, you are advised to contact your local agricultural specialist to discuss specific fertilizer recommendations.		
Magnesium	1350 kg/ha	-
No fertilizer guidelines are available for subgroups of crop. Therefore, you are advised to contact your local agricultural specialist to discuss specific fertilizer recommendations.		
Sulphur	408 kg/ha	-
Calcium	2097 kg/ha	-
Manganese	< 0.5 kg/ha	-
Zinc	48.8 kg/ha	-
Iron	230 kg/ha	-
Boron	3.1 kg/ha	-
Copper	15.3 kg/ha	-

QUALITY ASSURANCE

ALTIC laboratory works according to the international standard for test laboratories, NEN-EN-ISO/IEC 17025:2005. This implies that, within the laboratory, procedures are used to secure the quality from sampling to analysis. In the received sample (laboratory code 9746), differences with these procedures have been observed, which may have influenced the reliability of analytical results:

> The sampling date is unknown or incorrect, as a result of which the period of conservation has been expired.

Annex 5: Water analysis

ANALYSECERTIFICAAT

WATERANALYSE GLASTUINBOUW

ALTIC

MONSTER EN ONDERZOEK					HORTICOOP U.A.
Labnummer	:	5233			
Datum binnenkomst	:	14 april 2010	Monstername door	:	Opdrachtgever
Datum rapportage	:	14 april 2010	Datum monstername	:	Niet bekend
Aangeboden als	:				

TEELTGEGEVENS		
Gewas	:	Roos
EC(c) referentie	:	2.00

ANALYSERESULTATEN					WAARDERING		
Parameter			Resultaat	Eenheid	Correctie naar referentie EC	Streefcijfers	Waardering
Q	Geleidbaarheid	EC	1.3	mS/cm		2.0	
Q	Zuurgraad	pH	7.5	-		5.5	
Q	Ammonium	NH_4	< 0.1	mmol/l	-	< 0.5	
Q	Kalium	K	1.2	mmol/l	2.6	5.0	laag
Q	Natrium	Na	3.7	mmol/l	3.7		
Q	Calcium	Ca	2.3	mmol/l	5.0	5.0	
Q	Magnesium	Mg	1.9	mmol/l	4.2	2.5	hoog
Q	Nitraat	NO_3	3.7	mmol/l	8.1	12.5	
Q	Chloride	Cl	0.5	mmol/l	1.2		
Q	Sulfaat	[b] SO_4	3.3	mmol/l	7.3	2.5	hoog
Q	Fosfaat	[c] P	0.85	mmol/l	1.85	0.90	hoog
Q	Bicarbonaat	HCO_3	1.2	mmol/l	1.2		
Q	Silicium	Si	1.9	mmol/l	4.1		
Q	IJzer	Fe	1.22	µmol/l	1.22	25.00	laag
Q	Mangaan	Mn	< 0.10	µmol/l	< 0.10	3.00	laag
Q	Zink	Zn	< 0.10	µmol/l	< 0.10	3.50	laag
Q	Borium	B	2.40	µmol/l	2.40	20.00	laag
Q	Koper	Cu	< 0.10	µmol/l	< 0.10	1.00	laag
Q	Molybdeen	Mo	0.35	µmol/l	0.35	0.50	

TESTEN
RvA L360

ALTIC BV, De Drieslag 30, 8251 JZ Dronten, Postbus 135, 8250 AC Dronten, Telefoon (0321) 38 79 80,
Fax (0321) 38 79 88, K.v.K. Lelystad reg. nr. 39051603, lev. voorw. ged. 92/145, BTW-nr. 8005.92.797.B01,
Banknr. 33.81.49.554, BIC-Swift: RABONL2U, IBAN: NL63 RABO 0338149554, www.altic.nl

TOELICHTING

bij labnummer 5233 (14-04-2010)

OPMERKINGEN

[b] Het gerapporteerde sulfaatgehalte is gemeten als zwavel (S); hierbij is aangenomen dat alle zwavelverbindingen in het aangeboden monster als sulfaat aanwezig zijn

[c] Het gerapporteerde fosfaatgehalte is gemeten als fosfor (P); hierbij is aangenomen dat alle fosforverbindingen in het aangeboden monster als fosfaat aanwezig zijn.

De duitse en totale hardheid worden berekend uit het gehalte aan calcium en magnesium in het aangeboden watermonster

TOEGEPASTE METHODES

Voorbehandeling		Analysevoorschrift	Toegepaste norm(en) of richtlijn
Q Filtratie		AVW_FILTER	*Gelijkwaardig aan NEN-EN-ISO 11885*

Parameter	Afkorting	Analysevoorschrift	Toegepaste norm(en) of richtlijn
Q Zuurgraad	pH	AVW_PH	*Eigen methode*
Q Geleidbaarheid	EC	AVW_EC	*Eigen methode*
Q Nitraat	NO3	AVW_NO3	*Gelijkwaardig aan NEN-EN-ISO 13395*
Q Ammonium	NH4	AVW_NH4	*Gelijkwaardig aan NEN-EN-ISO 11732*
Q Chloride	Cl	AVW_Cl	*Gelijkwaardig aan NEN 6651*
Q Bicarbonaat	HCO3	AVW_HCO3	*Eigen methode*
Q Elementen Boor (B), calcium (Ca), koper (Cu), ijzer (Fe), kalium (K), magnesium (Mg), mangaan (Mn), molybdeen (Mo), natrium (Na), fosfor (P), zwavel (S), silicium (Si) en zink (Zn)		AVW_ICP	*Gelijkwaardig aan NEN-EN-ISO 11885*
Q Totaal ijzer	Tot-Fe	AVW_TOTFE	*Gelijkwaardig aan NEN-EN-ISO 11885*
Zuurverbruik	A	AVW_BUFFER	*Gelijkwaardig aan NEN 6497*
Duitse hardheid	dH	AVW_HARDHEID	*Eigen methode (berekening)*
Totale hardheid	GH	AVW_HARDHEID	*Eigen methode (berekening)*

BRONVERMELDING

Waardering en streefcijfers zijn afkomstig uit BEMESTINGSADVIESBASIS SUBSTRATEN 1999

KWALITEITSWAARBORGING

Het laboratorium van ALTIC werkt volgens de internationale standaard voor testlaboratoria, NEN-EN-ISO/IEC 17025:2005. Dit houdt ondermeer in dat, binnen het laboratorium, richtlijnen worden gebruikt om de kwaliteit in de keten van monsterneming tot analyse te verhogen. In het aangeboden monster (labnummer 5233) zijn verschillen met deze richtlijnen geconstateerd die de betrouwbaarheid van de analyseresultaten mogelijk hebben beïnvloed:

De bemonsteringsdatum is niet opgegeven, waardoor de conserveringstermijn mogelijk verlopen is.

TESTEN RvA L360

Annex 6: Fertigation regime

Tank	1000	liter
concentration	236	x

	NH4	K	N tot	Ca	Mg	NO3	Cl	Na	SO4	P	Ureum
	0,74	3,75	10,84	2,09	1,12	10,10			1,33	0,81	
Total in µmol/l	0,74	3,75	10,84	2,09	1,12	10,10			1,33	0,81	
Ref to drip EC	***0,31***	***1,59***	***4,60***	***0,89***	***0,48***	***4,29***			***0,56***	***0,34***	
lake/well		***0,20***		***1,20***	***0,90***		***0,40***	***2,00***			
Total gift	***0,31***	***1,79***	***4,60***	***2,09***	***1,38***	***4,29***	***0,40***	***2,00***	***0,56***	***0,34***	
Old fertigation program	0,17	1,95	3,36	2,13	1,40	3,19	0,40	2,00	0,98	0,36	

	Fe	Mn	Zn	B	Cu	Mo	Si	H	OH	EC
	12,05	6,59	1,95	11,68	0,72	0,93		2,62		
Total in µmol/l	12,05	6,59	1,95	11,68	0,72	0,93		2,62		1,41
Ref to drip EC	***5,12***	***2,80***	***0,83***	***4,96***	***0,31***	***0,39***		***1,11***		***0,60***
lake/well				***1,39***			***1,30***		***5,50***	***0,60***
Total gift	***5,12***	***2,80***	***0,83***	***6,35***	***0,31***	***0,39***	***1,30***	***1,11***	***5,50***	***1,20***
Old fertigation program	*5,40*	*2,95*	*0,87*	*6,62*	*0,32*	*0,42*	***1,30***	***0,70***	***5,50***	*1,20*

proportion n : k mmol

N	K
2,6	**1**

proportion of nitrogeen type's

NO3-N	NH4-N	Urea	N tot
93%	**7%**		**100%**

date	23-11-2011
Costs per 100.000Ltr	2185,94

Minimum irrigation EC in the rain season 1,4

Calcium Nitrate (CaNO3)		100 kg	A bak
Potassiumnitrate (KNO3) (A container)		37,5 kg	A bak
Magnesiumnitrate (Magnisal MgNO3)		25 kg	A bak
EDHHA 6%		2,5 kg	A bak
Nitric Acid 69%	40 litre		
Ammoniumnitrate vlb 18% N	10 Liter		B bak
Potassiumphosphate (MKP)		25 kg	B bak
Magnesiumsulphate (MgSO4)		37,5 kg	B bak
Potassiumsulphate		25 kg	B bak
Mangaansulfaat 32% (MnSO4)		250 gr	B bak
Sincsulphate 23% (ZnSO4)		125 gr	B bak
Borax 11% (Boron)		250 gr	B bak
Kopersulfaat 24% (Copper sulphate)		40 gr	B bak
Natriummolybdaat 40% (SOMO)		50 gr	B bak

Annex 7: Spray history

Grower:	
Altitude	
Cluster	

Mutate only the grey field

Month	Day	Starting time	Stopping time	GH. nr.	Variety:	From bay till bay nr. From	Till	Area in M2	Ave. Temp. °C inside GH	Chemical name	Disease	Rate in cc per 100 litre	Water used	Water/hec. in ltr	Total chemical in ltr / spray	Spray system

Group	Active Ingredient	Phase	Restistance	wetting agent adjuvants	Rate in cc / 100 l	Rate in cc /100 l gr MgO3	Rate in cc /100 l cc Nitric	Results	Price per ltr	Price total	Price Per 1000 m2

Annex 8: Scouting form

Input Scout format GH#

	Variety 1	Variety 2

	Side A bay nr.									Side B nr.								
Bay nr.	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	Bay nr.
1																		1
2																		2
3																		3
4																		4
5																		5
6																		6
7																		7
8																		8
9																		9
10																		10
Bay nr.	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	Bay nr.
	Side A bay nr.									Side B nr.								

LEGENDA:				
Thrips	T	Alive		Dead
Spider mites	S.	Alive		Dead
Downey	D.	Fresh		Old
Powdery	P.M.	Fresh		Old
Mealy bug	M.B	Alive		Dead
Botrytis	B.	Fresh		Old
Aphids	A.	Alive		Dead
Others: White fly, Catterpillars, Beetles, Butterfly eggs.	O.	Alive		Dead

DATE:

Crop protection Last spray and Action plan:

Spray history:						Action plan:					
Chemical	**Concentration**	**Field/Spot**	**Result**	**Date Last spray**		**When**	**Spot Field**	**Chemical**	**Concentration**	**Wetter/fertilizer**	**Adjust pH with**
					T						
					S.						
					D.						
					P.M.						
					M.B						
					B.						
					A.						
					O.						

Notes:	
T	
S.	
D.	
P.M.	
M.B	
B.	
A.	
O.	

Annex 9: Chemical stock list

Recommended Products	Dutch name chemical	Disease and pests controle	Active Ingredient	Rate / 100 ltr water	Stock ltr /Kg per ha.	sticker / wetter	pH of spray water.	Effects
Abelone	Vertimec	Mites	Abamectine	100 ml	10 ltr	Yes	5,0	All
Acarin T	Keltane	Insects	Tetradifon dicofol	150-200 ml	10 ltr	Yes	5,5	All
Ace	Orthene	Thrips	Acephate	80 gr	6 kg	No	5,5	Adult
Acrobat MZ	Paraat	Downey	Dimetomorph+Mancozeb	200 gr	15 kg	Yes	5,5	Preventive
Actara	Actara	Aphids	Thiamethoxam	50 gr	7 kg	Yes	5,0	All
Actellic	Actelic	Insects	Pirimiphos Methyl	50-100 ml	4 ltr	No	5,5	All
Agrifos 400	Kaliumfosfiet	Downey	Potassium Phosphite	200	10 ltr	No	5,5	Preventive
Agrifos 600	Kaliumfosfiet	Downey	Potassium Phosphite	150	10 ltr	No	5,5	Preventive
Agrixyl 407	@	Downey	Monopotassium phosphite 40%	200 ml	18 ltr	Yes	5,5	All
Akari	@	Mites	Fenproximate	100 ml	10 ltr	Yes	5,5	All stadia
Alliete	Aliette	Downey	Fosetyl Al	200-500 gr	15 kg	yes	5,0	Curative
Alto 100SL	@	Downey	Cyproconazole	25 ml	3 ltr	Yes	5,0	Preventive
Amagus	@	Mites	Diafenthiuron	60 ml	7 ltr	Yes	5,5	All stadia

(green)	Chemical can be used in combination with an IPM schedule with biological enemies
(orange)	Chemical can be used in combination with an IPM schedule with a limited waiting time of a maximum of 3 weeks
(red)	Chemical can't be used in combination with an IPM schedule; the wating time is longer than 5 weeks to start again with biological agents

Annex 10: Production summary

Basic data

Grower:	
Altitude	
Cluster	
Year:	
Nr of varieties:	
Amount of M2:	

DLV plant

Varieties:		Size in m2:	Go to fill in: (press on cell)			Summary	Planting date:
1			Stem weight	Input, exports and rejects	Input no market	Summary	
2			Stem weight	Input, exports and rejects	Input no market	Summary	
3			Stem weight	Input, exports and rejects	Input no market	Summary	
4			Stem weight	Input, exports and rejects	Input no market	Summary	
5							
Total:						Overview	

Weekly weight

Input weight per stem

Grower:
Variety:
M2:

Go to: INDEX

Period / 4 weeks	Week number	gr. Stemweight 20 cm	gr. Stemweight 25 cm	gr. Stemweight 30 cm	gr. Stemweight 35 cm	gr. Stemweight 40 cm	gr. Stemweight 50 cm	gr. Stemweight 55 cm	gr. Stemweight 60 cm	gr. Stemweight 70 cm	gr. Stemweight 80 cm	gr. Stemweight 90 cm
	1											
	2											
	3											
	4											
2011 01												
	5											
	6											
	7											
	8											
2011 02												
	9											
	10											
	11											
	12											
2011 03												

Weekly export and yield

Weekly input export and yield

Grower:
Variety:
M2:

GO TO: INDEX

Period / 4 weeks	Week number	Quantity rejects	Quantity 40 cm	Quantity 50 cm	Quantity 60 cm	Quantity 70 cm	Quantity 80 cm	Yield 40 cm in € total	Yield 50 cm in € total	Yield 60 cm in € total	Yield 70 cm in € total	Yield 80 cm in € total	Weight 40 cm gr / stem	Weight 50 cm gr / stem	Weight 60 cm gr / stem	Weight 70 cm gr / stem	Weight 80 cm gr / stem
	1																
	2																
	3																
	4																
2011 01																	
	5																
	6																
	7																
	8																
2011 02																	
	9																
	10																
	11																
	12																
2011 03																	

Ave. stem weight in gr / stem	Ave. Stem length in cm	Total # of stems	Yield total in €	Total rejects / m2	% rejects	Production area in m2	Production in stems / m2	Production in gr / m2	Yield / m2 in €	Ave. Price / stem in €	Yield / kg in €	Yield / kg stem length 40 cm	Yield / kg stem length 50 cm	Yield / kg stem length 60 cm	Yield / kg stem length 70 cm	Yield / kg stem length 80 cm

No market

Weekly input no market

Grower:
Variety:
M2:

GO TO: INDEX

Period / 4 weeks	Week number	Quantity 40 cm	Quantity 50 cm	Quantity 60 cm	Quantity 70 cm	Quantity 80 cm	Weight 40 cm gr / stem	Weight 50 cm gr / stem	Weight 60 cm gr / stem	Weight 70 cm gr / stem	Weight 80 cm gr / stem	Ave. stem weight in gr / stem	Ave. Stem length in cm	Total # of stems	Production area in m2	Production in stems / m2	Production in gr / m2
	1																
	2																
	3																
	4																
2011 01																	
	5																
	6																
	7																
	8																
2011 02																	
	9																
	10																
	11																
	12																
2011 03																	

Summary:

Grower:	
Altitude:	
Cluster:	
Year:	
Varieties:	
M2:	

Parameters cumulative Export incl. No Market 2011	
Production in stems / m2	
Production in grams / m2	
Average stem weight in gr / stem	
Average stem length in cm	
Rejects	
No market	
Parameters cumulative Export excl. Rejects & No Market	
Average price / stem in €	
Yield / m2 in €	
Yield / kg in €	

GO TO: INDEX

Overview Production and Yield 2011 Grower: Variety: Cluster: M2:

Export 2011	2011-01	2011-02	2011-03	2011-04	2011-05	2011-06	2011-07	2011-08	2011-09	2011-10	2011-11	2011-12	2011-13	Total
Production in gr / m2														
Total production in gram / m2 cum.														
Ave. stem weight in gr / stem														
Ave. Stem length in cm														
Production in stems / m2														
production in stems / m2 cumulative														
Ave. Price / stem in €														
Ave. Price / stem in € cumulative														
Yield / m2 in €														
Yield / m2 in € cumulative														
Yield / kg in €														
Total rejects / m2														
% rejects														

Overview Production and Yield 2011 Grower: Variety: Cluster: M2:

Export incl. No Market 2010	2011-01	2011-02	2011-03	2011-04	2011-05	2011-06	2011-07	2011-08	2011-09	2011-10	2011-11	2011-12	2011-13	Total
Production in gr / m2														
No Market														
Export														
Total														
Ave. stem weight in gr / stem														
No Market														
Export														
Average														
Ave. Stem length in cm														
No Market														
Export														
Average														
Production in stems / m2														
No Market														
Export														
Total														

Overview Production and Yield 2011 Grower: Variety: Cluster: M2:

Overview Yield / kg export 2010	2011-01	2011-02	2011-03	2011-04	2011-05	2011-06	2011-07	2011-08	2011-09	2011-10	2011-11	2011-12	2011-13	Total
Yield / kg stem length 25 cm														
Yield / kg stem length 30 cm														
Yield / kg stem length 35 cm														
Yield / kg stem length 40 cm														
Yield / kg stem length 50 cm														
Yield / kg stem length 55 cm														
Yield / kg stem length 60 cm														
Yield / kg stem length 70 cm														
Yield / kg stem length 80 cm														
Yield / kg stem length 90 cm														

Annex 11: Organic matter sources

Many of the organic materials used by growers are waste products of industry (including factory farming). It should be realised that these industries will increasingly be paying to get rid of their waste products. The price a grower now has to pay is already entirely determined by transport costs.

Farmyard manure
Farmyard manure includes the following categories: cow manure, pig manure, horse manure, old or fresh manure, high or low straw content. Fresh manure for young plants should be advised against because of the risk of ammonia damage. In view of the risk of plant diseases, nematodes, etc. farmyard manure must be applied before steam-sterilising the soil. As the soil is heavier and the straw-content lower, farmyard manure can have a puddling effect. With fresh manure with much straw nitrogen is fixed first and extracted from the ploughed layer. This should be taken into account when applying fertilizers.

Chicken manure
Chicken manure is available in 'fresh' and 'dried' (expensive) form. Also a distinction can be made between pure chicken manure or manure mixed with peat litter or sawdust (chicken litter manure). Chicken manure is rich in nutrients the contents of which may fluctuate strongly. The risk of excessive contents and ammonia burning is present. The annual application is ca 100 kg per are (not dried!).

Spent mushroom compost
This is a fine, loose manure which spreads easily. In addition to manure mixed with hyphae, it also contains clay and peat particles. It has a slow and relatively small fertilizing effect that is of special significance for potassium. The manure raises the pH.

Slurry
Slurry is a mixture of solid and fluid excrements. If a contracting firm carries out application, the use of slurry is saves labour. The slurry is then supplied by tankers and sprayed on the spot in the glasshouse. Annual application: 500 to 800 l per are. The organic matter content and the nutrient value are about half those of farmyard manure. It owes its effectiveness to nitrogen, phosphate and potassium. The Fertilization Act also applies to the use of this manure.

Cacao waste lime
Cacao waste lime is an industrial (waste) product. It contains much calcium carbonate. The material can be fresh (poison!) or old (forced). It has an effect on both organic matter supply and other nutrient elements, particularly lime.

Bark
This waste product of the paper industry can be fresh or composted. If fresh bark is used some extra nitrogen should be applied for decomposition. Bark mostly contains manganese. It may lead to problems with manganese toxicity on acid soils.

Straw (chopped)
This material has, as organic matter, a rather short effectivity period. The decomposition of straw requires plenty of nitrogen: 2 to 3 kg calcium ammonium nitrate per 100 kg straw. This nitrogen is released shortly afterwards. Straw supply is between 100 to 150 kg per are.

Sewage sludge
In the past, sewage sludge was applied, sometimes mixed with other materials. Currently its use must be strongly discouraged in view of the content of heavy metals, particularly cadmium.

Peat products
Peat litter and upgraded black peat are frequently applied peat products. They contain little or no nutrients and have an acidifying effect. Peat litter is made of slightly decomposed white peat, the

upper part of the peat stratum. Upgraded black peat forms from frozen, strongly decomposed black peat, the lower part of the peat stratum. Regular application of peat acidifies the soil, which may be prevented by extra liming. The combination of calcium + (oligotrophic) peat stimulates boron deficiency.

Crop shredding

Sometimes crops are shredded and ploughed in after cultivation. This is a form of organic matter supply. Shredded crops contain relatively high potassium and chloride. Extra nitrogen should be given, because some fixation as a result of decomposition occurs. This nitrogen becomes available for the plant again at a later stage.

Annex 12: Electric conductivity

Table: EC values of fertilizers (EC value of a solution of 1 gram per litre distilled water)

Fertilizer	Combination:	EC value in µS/cm:
Potassium nitrate	KNO_3	1.35
Sodium nitrate	$NaNO_3$	1.30
Calcium nitrate (solid)	$5(Ca(NO_3)_2.2H_20).NH_4NO_3$	1.24
Calcium nitrate (liquid)	$5(Ca(NO_3)_2.2H_20)$	0.63
Ammonium nitrate (liquid)	NH_4NO_3	0.86
Magnesium nitrate (liquid)	$Mg(NO_3)_2.6H_2O$	0.54
Ammonium sulphate	$(NH_4)_2SO_4$	1.90
Urea	$CO(NH_2)_2$	0.00
MAP (Mono-Ammonium Phosphate)	$NH_4H_2PO_4$	0.86
MKP (Mono-Potassium Phosphate)	KH_2PO_4	0.68
Potassium Sulfate	K_2SO_4	1.54
Magnesium sulphate	$MgSO_4.7H_2O$	0.94

Annex 13: Measuring soil EC by 1:2:2 extract

1. Collect soil at fifteen to thirty different places in your greenhouse
   - Depth of the sample: max. 30 cm
   - Collect soil close to the drip line, not too dry and not too wet
   - Always collect soil on the same day of the week, at the same time
   - Mix soil in a bucket

2. Collect 500 cc of the mixed soil

3. Mix this with 1000 cc distilled water (EC 0.0)

4. Mix it for 20 minutes until there is no soil left at the bottom

5. Give the mix of soil and water 10 minutes rest

6. Filter the water from the soil with a coffee filter

7. Check the EC and pH of the solution

Annex 14: Nutrient elements

Standard levels of elements in a rose plant

Table A.1: Standard levels of elements in a rose plant's mature leaf (mmol/kg dry matter)

Element	Standard value	Deficiency	Excess
Dry matter	23%*		
Macro elements:			
Nitrogen (N)	1700-2800	< 1430	
Potassium (K)	580-900	< 460	
Potassium success	250-280 mmol/l		
Phosphor (P)	100-200	< 65	
Calcium (Ca)	250-450	< 250	
Magnesium (Mg)	90-160	< 80	
Sulphur (S)	70-100		
Sodium (Na)	2-15		
Chloride (Cl)	20-50		
Micro elements:			
Iron (Fe)	1.0-2.7	< 0.9*	
Manganese (Mn)	1.1-2.7	< 0.5	> 5.5*
Zinc (Zn)	0.3-0.8	< 0.25	
Borium (B)	2.8-5.6	< 2.0	> 9.0*
Copper (Cu)	80-250 µmol/kg	< 50 µmol/kg	
Molybdenum (Mo)	15-30 µmol/kg		
Silicon (Si)	20-60		

*: Depending on the variety

Macro elements

Nitrogen (N)

Nitrogen is the most important and consumed off all elements for a rose plant. Nitrogen is applied to the crop in the form of ammonium (NH_4^+) and nitrate (NO_3^-). Ammonium can be directly absorbed by the plant; nitrate has to be converted into ammonium first. Nitrogen is a major component of chlorophyll, amino acids (building blocks of proteins), energy-transfer compounds (ATP) and nucleic acids such as DNA. Nitrogen is a mobile element, meaning it can be easily transported throughout the plant.

Table A.2: Nitrogen products

Ammonium Product	Formula	Typical N Content
MAP	NH_4H_2PO4	11%
Ammonium Nitrate	NH_4NO_3	34%
Ammonium Sulfate	NH_4SO_4	15%
Ammonium Chloride	NH_4Cl	
Urea	$(NH_2)_2OH$	46%
Nitrates		
Product	Formula	Typical N Content
Calcium Nitrate	$Ca(NO_3)_2$	11%
Potassium Nitrate	KNO_3	10%
Sodium Nitrate*	$NaNO_3$	16%
Magnesium Nitrate	$MgNO_3$	8%
Nitric Acid	HNO_3	

Potassium (K)

Potassium is always present in the liquid parts of the plant; it does not become part of the chemical structure of the plant. Potassium is absorbed by the plant in the form of K^+. Most of the Potassium is present in the vacuole of the cell. Here it determines the osmotic value of the cell fluid and is therefore responsible for cell turgor and the size of plant cells. It also plays a role in the opening of the stomata. Together with Calcium, Potassium is important for the permeability of cell membranes and activates different enzymes. Without potassium in the cell fluid, many enzyme reactions in metabolic cycles could not take place. Potassium is a mobile element.

Table A.3: Potassium products

Product	Formula	Typical K_2O Content
MKP (Mono Potassium Phosphate)	KH_2PO_4	
Potassium Phosphate	KPO_3	
Potassium Chloride	KCl_2	60%-62%
Potassium Sulfate	KSO_4	50%-53%
Potassium-Magnesium Sulfate	$K_2SO_4.2MgSO_4$	22%
Potassium Nitrate	KNO_3	

Phosphorus (P)

Phosphorous is an essential element for the plant. It is absorbed by the plant in the form of $H_2PO_4^-$ and HPO_4^{2-}. It plays a central role in energy supply for both photosynthesis and respiration. It is an essential component of certain proteins to make DNA and as a source of energy in the ADP / ATP energy transfer. Phosphorus is a very mobile element.

Table A.4: Phosphorus products

Product	Formula	Typical PO_4 Content
MAP (Mono Ammonium Phosphor)	$NH_4H_2PO_4$	49%
MKP (Mono Potassium Phosphate)	KH_2PO_4	52%
Phosphoric Acid	H_3PO_4	23%-33%

Magnesium (Mg)

Magnesium is an important element of chlorophyll. It is absorbed by the plant as Mg^{2+}. Applying sufficient magnesium increases the production of the plant, by stimulating more active chlorophyll and thus higher photosynthesis and assimilates production. Magnesium is a carrier of Phosphorus in the plant, and is both an enzyme activator and a component of many enzymes. Magnesium is a mobile element, except when present in older leaves, where it is build in as an immobile element.

Table A.5: Magnesium products

Product	Formula	Typical Mg Content
Epsom Salts	$MgSO_4.7H_2O$	10%
Magnitra	$MgNO_3$	16%
Potassium-Magnesium Sulfate	$K_2SO_4.2MgSO_4$	11%

Calcium (Ca)

Calcium is taken up by the plant as a Ca^{2+} ion. In the plant calcium can be found in normal form and is transported by the xylem of the plant. To get calcium to the young and not transpiration parts of the plant the root pressure has to be high. Calcium is a relatively immobile element.

Calcium provides structure of cell walls and membranes. A calcium deficiency can occur due to low transpiration (very low or high humidity), high Ammonium or Potassium levels, or high soil EC. A low Calcium level makes the crop more sensitive to fungus diseases.

Table A.6: Calcium products

Product	Formula	Typical Ca Content
Calcium Nitrate	$Ca(NO_3)_2$	19%
Calcium Chloride	$CaCl$	36%
Gypsum	$CaSO_4.7H_2O$	22%

Sulfur (S)
Sulfur is taken up by the rose plant as sulfate (SO_4^{2-}). Sulphur is a building block of proteins, enzymes and vitamins and is a key ingredient in the formation of chlorophyll. Sulfur is an immobile element. It is therefore difficult to transport within the plant.

Table A.7: Sulfur products

Product	Formula	Typical S Content
Aluminium Sulfate	$Al_2(SO_4)_3$	14,4%
Ammonium Sulfate	$(NH_4)_2SO_4$	24%
Ammonium ThioSulfate	NH4S2O3	26%
Calcium Sulfate	$CaSO_4$	15%-17%
Epsom Salts	$MgSO_4.7H_2O$	14%
Ferrous Sulfate	$FeSO_4$	12%
Potassium Sulfate	K_2SO_4	17,5%
K-Mag	$KMgSO_4$	22%
Sulfuric Acid	H_2SO_4	32%

Silicon (Si)
A rose plant takes silicon as a main element, while other plants take up Silicon as a trace element. In roses is it not yet clear what function it has on the plant but it gives a higher yield if added at the soil or substrate.

Table A.8: Silicon products

Product	Formula	Typical Si Content
Potassium Silicate	K_2SiO_3	

Micro elements

Iron (Fe)
Iron is a component of certain enzymes and proteins, and plays a role in plant respiration, metabolism and nitrogen fixation. Plants can uptake iron in its oxidized forms Fe^{2+} and Fe^{3+}, but the Fe^{2+} form is physiologically more significant for plants. Iron is an immobile element.
Iron is an immobile element. Iron deficiency is the most common deficiency in the rose cultivation, which shows especially in the youngest leaves. It may be due to a high pH, high bicarbonate (HCO_3^-) concentration, poor absorption by poor root systems and competition between other metals like Zinc and Manganese.

Table A.9: Iron products

Product	Formula	Typical Fe Content
Ferrous Sulfate	$FeSO_4.7H_2O$	20%
Ferrous Ammonium Sulfate	$(NH_4)_2SO_4.6H_2O$	14%
Iron DTPA Chelate	FeDTPA	3%-6%
Iron EDDHA Chelate	FeEDDHA	3%-6%

Manganese (Mn)

Manganese primarily participates in and catalyzes different enzyme systems and processes. In the photosynthesis process it contributes to carbon dioxide uptake, transport of electrons and is involved in the 'Hill reaction', where water is split in H^+ and O_2. Furthermore it plays a role in the synthesis of chlorophyll and formation of vitamins. It is taken up by the plant as Mn^{2+}. It is an immobile element. Excess of Manganese is possible. This will result in low uptake of Iron and subsequent Iron deficiency.

Table A.10: Manganese products

Product	Formula	Typical Mn Content
Manganese Sulfate	$MnSO_4.H_2O$	23%-28%
Manganese (Manganous) Oxide	MnO	41%-68%
Manganese Chelate	MnEDTA	5%-12%

Copper (Cu)

Cupper is involved in numerous physiological functions as a component of several enzymes, mainly those who participate in electron flow and catalyze photosynthesis and respiration processes. Furthermore it is important to formation of lignin in plant cells walls, which contributes to the structural strength of cells. In excessive quantities it becomes toxic and interferes with the same photosynthesis and respirations processes and protein synthesis. It is taken up by the plant as Cu^{2+}. Copper is an immobile element.

Table A.11: Copper products

Product	Formula	Typical Cu Content
Copper Sulfate Monohydrate	$CuSO_4.H_2O$	35%
Copper Sulfate Pentahydrate	$CuSO_4.5H_2O$	25%
Cupric Oxide	CuO	75%
Copper Chloride	$CuCl_2$	17%
Copper Chelates	CuEDTA	8-13%

Zinc (Zn)

Zinc plays a role in cell elongation of the stem and leaves. It contributes to the production of auxin (plant hormone), formation of chlorophyll and carbohydrates. Furthermore Zinc enables plants to withstand low temperatures. One reason for Zinc deficiency can be high level of Potassium in the soil. Zinc is taken up by the plant as Zn^{2+}.

Table A.12: Zinc products

Product	Formula	Typical Zn Content
Zinc Sulfate	$ZnSO_4.H_2O$	36%
Zinc Oxy-Sulfate	$ZnO\text{-}Zn\ SO_4$	38%-50%
Zinc Oxide	ZnO	50-80%
Zinc Chloride	$ZnCl_2$	50%
Zinc EDTA Chelate	ZnEDTA	6%-14%
Zinc HEDTA Chelate	ZnHEDTA	6%-10%

Boron (B)

Boron is taken up by the plant as BO_3^{2-} and is an immobile element. Boron contributes to the transport of glucose formed during the photosynthesis process. Furthermore it is important for the stability of the cell wall and it is necessary for normal cell division, nitrogen metabolism, and protein formation.

Table A.13: Boron products

Product	Formula	Typical B Content
Borax	$Na_2B_4O_7.10H_2O$	11%
Boric Acid	H_3BO_3	17%
Sodium Tetraborate	$Na_2B_4O_7.(0\text{-}10)H2O$	10%-20%
Solubor	$Na_2B_{10}O_{16}.H_2O$	20%

Molybdenum (Mo)

Molybdenum is taken up by the plant as MoO_4^{2-}. Molybdenum is important for converting nitrate into ammonium, so it's available to the plant. Molybdenum is a relatively mobile element.

Table A.14: Molybdenum products

Product	Formula	Typical Mo Content
Sodium Molydate	$Na_2MoO_4.2H_2O$	39%
Molybdenum Trioxide	MoO_3	66%
Ammonium Molydate	$(NH_4)_6MoO_{24}.2H_2O$	54%

Annex 15: Pests and diseases

Pests

Spider Mite

The most common species of spider mite to be found in Ethiopian rose crops are the Two-Spotted and Red Spider Mite. Spider mite prefer to live on the bottom side of leaves, where they may spin protective silk webs and cause damage by puncturing the plant cells to feed. Feeding marks are shown as small yellow speckled spots and can be mistaken for fertilizer deficiencies. Spider mites prefer hot and dry conditions and are highly reproductive. Under favourable conditions they become full-grown in as little as a week after eggs hatch. After mating, mature females may produce a dozen eggs daily for a couple of weeks. The fast development rate and high egg production can lead to extremely rapid increases in mite populations.

Figure: Two-Spotted Spider Mite

Chemical control of spider mites is difficult. Generally it involves pesticides that are specifically developed for spider mite control (miticides). Few insecticides are effective for spider mites. As they are small of size, live close to the veins of the plant and on bottom sides of leaves, it is difficult to reach them by spraying, so thorough coverage is essential. Furthermore, most insecticides do not affect eggs (so repeated application after 10 - 14 days is required) and their accelerated reproductive rate allows spider mite populations to adapt quickly to resist pesticides. Natural enemies include small lady beetles, predatory mites, minute pirate bugs, big-eyed bugs and predatory thrips, which provide options for biological control.

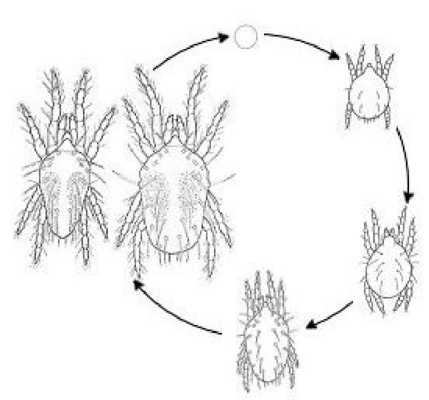


Figure: Development Cycle Spider Mite

Thrips

Thrips are tiny, slender and elongated insects, yellowish or brown in colour and approximately 1 - 2 millimetres in length. The adults are weak fliers and usually only take short flights from leaf to leaf or plant to plant. Adult thrips can be transported on air currents and will enter the greenhouse through vents and doorways.

Figure: Thrips

The adult and larvae feed on plants by piercing the plant surface with their mouthparts and sucking the contents of plant cells. Damage symptoms include feeding scars and distortion of leaves. Flowers are particularly attractive to thrips resulting in damage such as scarring of petals, distortion of flowers and flower buds, and incomplete petal expansion. Feeding marks are shown as small silver-grey spots. Their faecal spots may appear as black spots. At high infection levels leaves may wither. The rate at which thrips reproduce is highly dependent upon environmental conditions, incl
uding the temperature and nutrient quality of their food source. It is important to regularly check mature flowers and young shoots for thrips. Sticky signal plates (blue) should be used to observe the presence of thrips. Chemical control of thrips can be difficult. Thrips feed deep within flower heads or, on bottom sides of leaves or on developing leaves, which makes it difficult to target

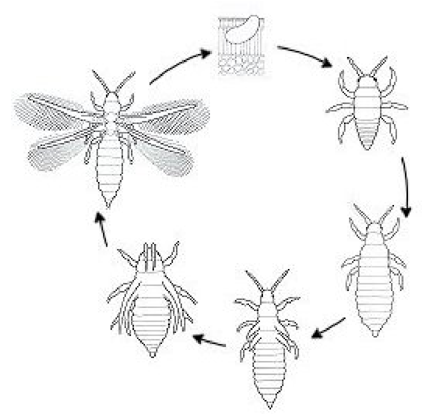


Figure: Development Cycle Thrips

them by spraying, so thorough coverage is essential. Furthermore, they can build up of resistance to insecticides. Various predatory mites and minute pirate bugs provide options for biological control.

White Fly

White flies are small winged, long insects, white coloured and are about 1.5 - 2 millimetres in size. White flies are related to aphids. Both adult white flies and larvae feed on plants by piercing leaf tissues, causing substantial damage to the leaves and reduction in plant vigour. Furthermore, they excrete large amounts of sugary substance (honeydew) which attracts other pests and mainly promotes the growth of black sooty mould fungus and thereby reducing photosynthesis and crop quality. Eggs are laid on the under side of the youngest leaves, and are too small to be seen clearly with the bare eye.

Figure: White Fly

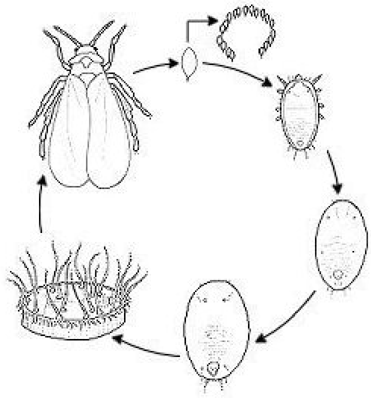


Figure: Development Cycle White Fly

Sticky traps or signal plates (yellow) should be used to trap adult whiteflies or to observe their presence in the greenhouse. White flies can be controlled chemically, but have shown an ability to build up resistance to pesticides. Natural enemies include parasitic wasps, small black ladybeetles and predatory bugs.

Caterpillar

There are different types of butterfly caterpillars that cause damage to the rose plant. The main butterflies that are found in the greenhouse are the trukish moth, the fruit moth and the floridamot. Butterflies undergo four stages of development: egg, caterpillar, pupa and butterfly. The caterpillar does the damage to crop. The small larvae scrape the leaf surface on the underside of the leaf. The upper epidermal layers of the leaf stay intact. As the caterpillar grows, it spreads and with it's well develop head with strong jaws it will eat the whole of the leaf, damaging the leaves and thereby reducing photosynthesis and crop quality. The large amounts of excrement they produce contaminate the crop. Caterpillars can be controlled chemically and with natural enemies.

Figure: Catterpillar

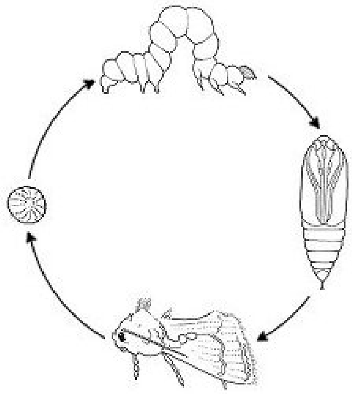


Figure: Development Cycle Caterpillar

Aphids

Aphids are soft-bodied insects, with long legs and antennae and are about 2 - 3 millimetres in size. Colour patterns range between black, grey, red, yellow and green. Adult aphids are predominantly wingless. However, winged adults can develop under conditions of high population density. This allows them to move into a greenhouse from outside, or to spread rapidly within a greenhouse. Aphids pierce plant tissue with their mouth parts and suck out the sap, causing deformed leaves and flowers. They excrete large amounts of sugary substance (honeydew) which attracts other pests, virus diseases and mainly promotes the growth of black sooty mould fungus and thereby reducing photosynthesis and crop quality. Aphids are mainly active under warm conditions and their numbers can rapidly build up to very large populations.


Figure: Aphids on rose

Regularly monitoring for aphids is done by visual observation and by using yellow sticky traps (for detecting winged aphids) and is essential for early detection and control (before winged adults are produced). Mostly only spot treatments or removal of infested plants are necessary. Chemical control with pesticides can be done ass well and sometimes is compatible with biological control. Natural enemies include parasitic wasps, predatory midges and ladybeetles.

Mealy Bug

Mealy bugs are soft bodied critters, elongated and oval in shape, with a segmented body and are about 2.5 - 5.5 millimetres in size. They are covered with a waxy material that makes them look powdery or cotton-like. This makes detection reasonably easy. Nymphs and female adults feed on the plant sap, which reduces growth and can cause deformation and/or yellowing of the leaves. Furthermore, a sugary substance (honeydew) promotes the growth of the black sooty mould fungus. Together with the white waxy secretions this reduces photosynthesis of the leaves and causing the production to decrease.


Figure: Mealy Bug

Mealy bugs can be controlled chemically or biologically with mini-wasps, beneficial fungi, lady beetles and lacewings.

Nematodes

Nematodes are a totally different pest as compared to the ones discussed above. Nematodes are roundworms that infect the plant roots and therefore are very difficult to detect. Root-knot nematodes are the most common nematodes. These parasitic nematodes suck and drain the fine rose roots and create knots in the smaller roots limiting the development of the root system. The tiny swellings (galls) appear all over the rose roots. Roots that are damaged by these nematodes can no longer take up water or fertilizer into the upper parts of the plant. Infection of young plants can be lethal, while infection of mature plants causes reduced production. There are many different species, all crop / host specific.


Figure: Root-knot nemathode


Figure: Root-knot (left) and normal root (right)

Nematodes can be controlled by fumigating the soil before planting (e.g. with methyl bromide), or by planting nematode resistant varieties or rootstocks. Nematodes can be controlled chemically.

Cut worm

Cutworms, which biologically speaking are not worms but caterpillars, are the larvae of several types of moths. Cutworms are usually green, brown, grey, or yellow soft-bodied caterpillars, often with longitudinal stripes, up to 2.5 cm in length. The worms hide in the soil during the daytime and attack rose plantings at night. Their natural habit is outdoors, but they can find their way into the greenhouse as moths fly in and deposits eggs on plants. Damage to plants infected by these pests varies, depending on the type of cutworm. A larva typically attacks the first part of the plant it encounters, namely the stem and cut rose stems down at the soil line. Thus it got the name cutworm.


Figure: Cut worm

Cultural control of cut worms includes removing weeds from around rose plantings, which will reduce the number of available sites for moths to lay their eggs. Cut worms can also be controlled chemically.

Diseases

Powdery Mildew

Powdery mildew is a fungal disease and appears as white or gray powdery spots and growth of fungus mycelium over the surface of leaves, stems or flowers. Leaf curling and twisting may indicate it's presence before it is actually visible. Severe infection can result in yellowed, dried and brown leaves, and deformed shoots and flowers. Photosynthesis can be reduced significantly when enough leaf area is covered with powdery mildew. Young leaves and shoots are particularly sensitive.

Figure: Powdery Mildew

Powdery mildew favours warm, dry conditions with poor air circulation and does not need the presence of water for infection to occur. However, relative humidity needs to be high for spore germination. Spores of the fungus are transported mainly by air to other parts of the plant, or to other nearby plants.

Cultural control of powdery mildew includes removing and destroying of all infected and dead plant material, to prevent future infections. Selectively pruning of overcrowded plant material can help to increase air circulation and reduce relative humidity and infection. Chemical control of powdery mildew is most effective, as most of the growth of the fungus is found on the plant surfaces that are easy accessible by fungicides. Sulphur evaporators, which spread sulphur in gas form on the crop, are commonly used as and additional measure against powdery mildew. One sulphur container is needed for about every 100 m^2 and should be placed above the crop. Preventive control is recommended, as infection can cause serious production and quality loss. Furthermore, several rose varieties are developed as resistant or tolerant to powdery mildew.

Figure: Sulphur container

Downey Mildew

Downey mildew is a fungal disease that penetrates the plant surface, producing intercellular mycelium inside young leaves, stems and flowers and appears as purple to red or brown irregular spots on the leaf surface. Sometimes appearance of white mycelium on the underside of the leaf can be observed, but the production of spores is sparse and therefore the disease is difficult to diagnose.

Figure: Downey Mildew

Downey mildew can develop quickly, especially under favourable moist, humid and relatively cool conditions (rainy season), and severely damage the leaves reducing photosynthesis and causing production and quality loss. The spores are spread mainly by air or water.

Cultural control of downey mildew includes removing and destroying of all dead and infected plant material, to prevent future infections. Selectively pruning of overcrowded plant material, to increase air circulation, and lowering the relative humidity will reduce disease development. Downey Mildew can be chemically controlled with fungicides.

Botrytis

Botrytis is a fungal disease that appears on leaves, stems and flowers as a gray or brown fuzzy material. It will prevent flower buds from opening and causes the flower petals to turn brown and shrivel up. Visual damage by Botrytis may also become apparent after transport or during vase life only. Before shipment the disease can be latent present on the flower. A test for Botrytis on the farm determines if the disease is present on the flowers before shipment. Botrytis favours rainy, moist and high humidity climatic conditions and spores need water for germination. Good ventilation and keeping relative humidity low are thus important to prevent infection by botrytis. Selectively pruning of overcrowded plant material, to increase air circulation, and lowering the relative humidity will reduce or discontinue disease development. The spores are spread mainly by air and are everywhere.


Figure: Botrytis

Cultural control of Botrytis includes removing and destroying of all dead and infected plant material, to prevent future infections. Botrytis can be chemically controlled by preventive of curative spraying with fungicides.

Agrobacterium

Agrobacterium is a bacterial disease that causes crown gall disease in plants. It appears by tumour growth (gall) on the infected plant, mostly at the junction between the roots and the shoot, just above soil level. It enters the plant by wounds, which attract Agrobacterium. Wounds can be caused by nematodes, insects, vegetative propagation or harvest activities. The bacteria transform the plant cells, changes them so they produce food and cause rapid unlimited cell division. The bacterium presence in the soil is common and it can survive for many years on dead, organic material. It spreads from plant to plant through soil or water.


Figure: Agrobacterium


Figure: Removed agrobacterium and wound painted with copper solution

In general, bacterial diseases of plants are very difficult to control, because of the lack of effective chemicals. The most effective way to control agrobacterium is to prevent infection (clean planting material, use sharp scissors for harvesting, limit damage and wounds to the plant). When the plant does get infected, the tumour should be removed and the remaining wound has to be covered with copper. The removed material should be destroyed or removed from the farm.

Black spot

Black spot is a fungal disease that appears as round or irregular shapes on the upper surface of leaves. The black spots are often surrounded by chlorosis (yellowing of leaves). Intensive infection will lead to high rates of chlorosis and damage to the leaves and eventually defoliation that weakens the plant, leading to less blooming and greater sensitivity to other stress factors.

The fungus overwinters on dead plant material and spores are easily spread via water splashed on leaves or air currents. Black spot favours wet foliage and high humidity. Good ventilation and keeping foliage dry and relative humidity low are thus important to prevent infection Selectively pruning of overcrowded plant material, to increase air circulation, and lowering the relative humidity will reduce or discontinue disease development. Cultural control of Botrytis includes removing and destroying of all dead and infected plant material, to prevent future infections. There are varieties available that have resistance to black spot.


Figure: Black spot

Chemical control with fungicides is possible, but should be done in combination with cultural and sanitation practices.

Annex 16: Biological contral agents

Phytoseiulus persimilis

Phytoseiulus persimillis is a tiny predatory mite (about 0.5mm), which feeds on spider mite. The adults are very active, with a teardrop-shaped orange to bright-orange colored body with long legs and are slightly larger than its pray.


Figure: Phytoseiulus persimilis

The adult females lay about 60 eggs in a lifetime, which hatch in 2 to 3 days. The larval stage does not need food to develop. The nymphs and adults feed on all stages of the spider mite by sucking the body fluid, after which the spide mites are visible as small dark / brown spots on the leaves. The mite is very voracious and consumes between 5 and 20 prey per day (mites and / or eggs). Phytoseiulus persimillis is most active at high relative humidity (+70%) and temperatures that reach regularly above 20°C. The mites can not do without food and therefore can not be used preventive control.

Amblyseius californicus

Amblyseius californicus is predatory mite, which feeds on spider mites. The adults are yellow-orange in color, with a drop-shaped body with short legs. The development from egg to adult mite takes about 6 days at a temperature of 25 ° C.


Figure: Amblyseius californicus

The adult predatory mite lives about 20 days and lays about 60 eggs in a lifetime. As a larval, Amblyseius californicus prefers to feed on the younger stages of the spider mite. The adult females eat all stages of spide mites. If sufficient prey is available, Amblyseius californicus eats fewer spider mites (about 5 adult spider mites and some eggs and nymphs) than Phytoseiulus persimilis. However, Amblyseius californicus can also survive and feed on other mites than spider mites and on pollen, and can survive several days without prey. Therefore they can also be introduced for preventive control. At low prey densities they are more effective than Phytoseiulus persimilis.When they haven't fed for a while, the turn skinny with a uniform light color. Especially in crops where high temperature and/or relative humidity variations occur, Amblyseius californicus will perform much better than Phytoseiulus persimilis

Amblyseius swirskii

Amblyseius swirskii is a polyphagous predatory mite, meaning that it feeds on several preys. However, it prefers whitefly and thrips. Amblyseius swirskii also feeds on pollen and in a certain degree on spider mites.


Figure: Amblyseius swirskii

In optimal climate and feeding conditions, its total life cycle will take 5 to 6 days and the females will lay about 2 eggs. The optimal development temperature is between 25°C and 28°C and the predatory mite stays even active up to temperatures of 40°C. Nevertheless, under 15°C it is inactive. The humidity has also a restrictive influence on the development of this predatory mite. The critical limit is about 70 % relative humidity. A population of Amblyseius swirskii will grow very fast and will spread among the crop as long as the ideal circumstances are met.

Annex 17: Reasons for blind shoot development

- *Blind shoot development is variety sensitive and depends on the power to grow.* Easy growing, vegetative variety's (e.g. Duett) are a lot less sensitive to blind shout development than more woody variety's (e.g. Marie-Claire).
- *Competition between shoots and apical dominance plays a role in the development of blind shoots.* When on one branch two eyes are present, usually the lower eye develops into a blind shoot. The upper eye suppresses the lower eye, as the upper eye absorbs more assimilates and hormones than the lower eye. In that case the lower eye does not have enough assimilates to develop a flower.
- *Level of light influences development of blind shoots.* Development of blind shoots is usually observed during or after periods of low light (e.g. during winter period) and light is the limiting factor. During periods of low light, the production of assimilates is low and are not enough to develop a flower. Thick, vigorous stems are less sensitive to development of blind shoots as compared to thin stems.
- *Temperature influences the development of blind shoots.* A crop grown at high temperatures and under low light levels, produces thinner shoots that are more sensitive to developing into blind shoots.
- *Level of CO_2 influences development of blind shoots.* A higher level of CO_2 reduces the development of blind shoots, as more assimilates can be produced (if no other growth factors are limiting).
- *Hormones possibly play a role in the development of blind shoots.* Flowering shoots have high levels of auxine, gibberellin and cytokinin. Blind shoots have high levels of abscisic acid.
- *Cropping strategy (flush or staggered cropping) influences the development of blind shoots.* To prevent the development of blind shoots, the crop should be in balance regarding production, harvesting, uptake of (light,) water and nutrients. A crop which is in flush will produce more blind shoots. The amount of foliage, the Leaf Area Index (LAI, optimal value between 3-4), should also be enough and not a limiting growth factor for production of assimilates. Therefore, shortage of (fresh) bend stock results in the development of blind shoots.
- *Type of cut point plays a role in the development of blind shoots*. Thin cut points are more sensitive for development of blind shoots than cut points on thick stems.

Annex 18: Cost price calculation

Info

Company details		
Company name:		
Total surface:		m2
Altitude:		Meters above sealevel

Today's currency rates		
EUR		USD
EUR		ETB
USD		ETB

Variety's	Surface in m2
☑ Viva!	
☐ Duett	
☐ Marie-Claire!	
☐ Bella Rose	
☐ Red Sky	
☐ Blizzard	
☐ Red Calypso	
☐ Mariyo!	
☐ High Society	
☐ High & Magic	
☐ Variety1	
☐ Variety2	

Fixed costs

All the fixed costs concerning the company can be calucalted here if filled in correctly.
All the data has to represent a period of 4 weeks and all the costs are in ETB.

Fixed costs	Cost item	Costs	
Energy	Electricity		
	Gas/oil/fuel		
Maintenance excl. Labor	Greenhouse		
	Water supply/irrigation		
	Fertilization / Crop Prot.		
	Coldstore & Post harvest		
	Vehicles & Machinery		
	Unforeseen		
Other	Insurance		
	Lease		
	Royalties		
	Total fixed costs	-	ETB

Labour costs

Here all the labor costs concerning the company can be calculated if filled in correctly, employees at the head-office should also be included in this calculation. Every salary has to represent the gross-salary.
All the data has to represent a period of 4 weeks and all the costs are in ETB.

Salary paid every		Days

Labor	Number of employees	Average Gross-Salary	Salary per 4 weeks	Total costs	
Management					
Supervisors					
Greenhouse					
Packhouse					
Spray					
Irrigation					
Maintenance					
Other					
			Total Labor costs	-	ETB

Additional costs

Here all the costs of additional products used for the production of the roses can be calculated if filled in correctly. The royalties also include the plant materials. **All the data has to represent a period of 4 weeks and all the costs are in ETB.**

Products		Total costs	
Crop protection	Chemical Products		
	Biological Products		
Fertilization	Chemical Products		
	Biological Products		
	Total product costs	-	ETB

Packing

Variety	

Here all the costs concerning the packing of the chosen variety can be calculated if filled in correctly. # Stands for amount. **All the data has to represent the chosen variety and all the costs are in ETB.**

		Rubber Band					Wrapping Paper					
Length	Stems per bunch	# Purchased	Purchase costs	Price per band	# Per bunch	Costs per stem	M per Roll	Price per roll	Price per M	M per bunch	Costs per bunch	Costs per stem
80												
70												
60												
50												
40												
35												
30												

		Box			Strap						
Length	Stems per bunch	Bunches per box	Price per box	Costs per stem	M per roll	Price per roll	Price per M	M per strap	# per Box	Costs per stem	Total packing costs per length
80	0										ETB per stem
70	0										ETB per stem
60	0										ETB per stem
50	0										ETB per stem
40	0										ETB per stem
35	0										ETB per stem
30	0										ETB per stem

Export

Variety	

Here all the costs concerning the exporting of the chosen variety can be calculated if filled in correctly. **All the data has to represent the chosen variety.**

		Unpacking costs (per stem in Euros)				Auction costs (per stem in Euros)							
Length	Packrate	Handling	Transport	Marketing %	Cost per stem	Bucket Tax	# per bucket	Cart Tax €	Buckets per cart	Shipment Tax	Membership %	Cost per stem	Total Export costs per length
80													ETB / stem
70													ETB / stem
60													ETB / stem
50													ETB / stem
40													ETB / stem
35													ETB / stem
30													ETB / stem

Transport Ethiopia	Costs per box	
Road Transport		ETB / Box
Customs		ETB / Box
Handling Airport		ETB / Box
Air-freight		USD / Kg
Fuel Charge		USD / Box
Cost per box		ETB / Box

Transport Netherlands	Costs per box	
Handling Airport		EUR / Box
Customs		EUR / Box
Road Transport		EUR / Box
Cost per box		ETB / Box

Total Transport costs per box		ETB / Box

Volume per box
kg

Turnover

Variety	

Here the turnover for a period of 4 weeks can be calculated for the chosen variety if filled in correctly. The # represents the amount of products. **All the data has to represent the chosen variety and all the prices are in Euros**

Day	Sun.	Mon.		Tue.		Wen.		Thu.		Fry.		Sat.	Sun.	Mon.		Tue.		Wen.		Thu.		Fry.		Sat.
		#	Price	#	Price	#	Price	#	Price	#	Price			#	Price	#	Price	#	Price	#	Price	#	Price	
80																								
70																								
60																								
50																								
40																								
35																								
30																								
Total #																								
Turnover																								

Day	Sun.	Mon.		Tue.		Wen.		Thu.		Fry.		Sat.	Sun.	Mon.		Tue.		Wen.		Thu.		Fry.		Sat.			
		#	Price	#	Price	#	Price	#	Price	#	Price			#	Price	#	Price	#	Price	#	Price	#	Price		Total #	Total Turnover	
80																											ETB
70																											ETB
60																											ETB
50																											ETB
40																											ETB
35																											ETB
30																											ETB
Total #		0		0		0		0		0				0		0		0		0		0					ETB
Turnover		0		0		0		0		0				0		0		0		0		0					

Summary

Variety	

Cost price per m2		Costs	Percentage
Fixed	Energy		
	Maintenance		
	Other		
	Royalties		
Labor	Management		
	Supervisors		
	Greenhouse		
	Packhouse		
	Spraying		
	Irrigation		
	Maintenance		
	Other		
Additional	Crop protection		
	Fertilization		
Packing	Materials		
Export	Unpacking		
	Auction		
	Transport Eth.		
	Transport Nether.		
	Cost price per m2		ETB/m2

Cost price per stem		80 cm	70 cm	60 cm	50 cm	40 cm	35 cm	30 cm	
Fixed	Energy								
	Maintenance								
	Other								
	Royalties								
Labor	Management								
	Supervisors								
	Greenhouse								
	Packhouse								
	Spraying								
	Irrigation								
	Maintenance								
	Other								
Additional	Crop protection								
	Fertilization								
Packing	Materials								
Export	Unpacking								
	Auction								
	Transport Eth.								
	Transport Nether.								
	Cost price per stem								ETB/stem
	Non-export cost price								ETB/stem

Profit

Variety	

					All Variety's		
	Cost price	Turnover	Profit		Total Turnover	Total Profit	
80				ETB			ETB
70				ETB			ETB
60				ETB			ETB
50				ETB			ETB
40				ETB			ETB
35				ETB			ETB
30				ETB			ETB
		Total		ETB			ETB

Profit per m2		ETB