Development of the Commercial Horticulture Sector Northwest of Mount Kenya from 2003 to 2013 and Its Impact on River Water Resources of the Upper Ewaso Ng'iro Basin

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Leiter der Arbeit:

Prof. Dr. Urs Wiesmann

Co-Leiter der Arbeit:

Dr. Hanspeter Liniger

Development of the Commercial Horticulture Sector Northwest of Mount Kenya from 2003 to 2013 and Its Impact on River Water Resources of the Upper Ewaso Ng'iro Basin

Master Thesis Submitted to the Faculty of Natural Science of the University of Bern by **Nora Lanari**

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Supervisor: Prof. Dr. Urs Wiesmann

Co-Supervisor: Dr. Hanspeter Liniger

Center for Development and Environment (CDE)

Institute of Geography, University of Bern

Front cover: Photographs by Nora Lanari

Supervision: Prof. Dr. Urs Wiesmann (Institute of Geography, Center for Development and Environment (CDE))

Dr. Hanspeter Liniger (Institute of Geography, Center for Development and Environment (CDE))

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This study was conducted with only the best intentions. Any shortcomings, interpretations, and conclusions drawn are entirely my responsibility.

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Nora Lanari

Zusammenfassung

Der Mount Kenya gilt als Wasserschloss in einer ansonsten Savannen-dominierten Landschaft. Die semi-ariden und ariden Gebiete im Nordwesten sind daher abhängig von perennierenden Flüssen die dem Berg entspringen. Folglich hat die Flusswassernutzung in den Oberläufen starke, oft belastende, Konsequenzen für Nutzer in den Unterläufen. Im Verlauf der 1990er Jahre erlangten in diesem Zusammenhang die neuen exportorientierten, mittel- und grossbetriebliche bewässerte Gartenbaufarmen zunehmende Wichtigkeit als Akteure im Hinblick auf den sozioökonomischen und naturräumlichen Wandel im Gebiet. Mit der erhöhten Wassernachfrage stieg ebenfalls das Konfliktpotential um die Wasserverteilung während der Trockenzeit. Die folgende Studie untersucht die Entwicklung des kommerziellen Gartenbausektors und dessen Auswirkungen auf die Nebenflüsse des *Upper Ewaso Ng'iro Basin,* um so ein besseres Verständins dieser Akteur-Kategorie bereitzustellen. Eine Studie über den Einfluss von kommerziellen Gartenbaubetrieben auf die Flusswasserressourcen des Untersuchungsgebietes wurde zum ersten Mal von Roland Schuler (2004) durchgeführt, wobei er die Zeitspanne von den Anfängen des Sektors in 1991 bis 2003 untersuchte. Diese Folgeuntersuchung behandelt die weitere Entwicklung des Sektors von 2003-2013. Anhand von Experteninterviews wurden vier Forshcungsschwerpunkte untersucht: das Inventar und die Struktur des Sektors, die wichtigsten Entwicklungsfaktoren von 2003-2013, die Auswirkungen des Sektors auf lokale Flusswasserressourcen, sowie dessen sozioökonmische Einflüsse auf die Region. Die Studie zeigt, dass der kommerzielle Gartenbausektor weiterhin wächst: die Anzahl Farmen im Untersuchungsgebiet stieg von 28 auf 35. Demensprechend nahm die bewirtschaftete Fläche von 1085 ha auf 1385 ha zu. Der Schwerpunkt des Sektors verschob sich vom Gemüseanbau auf den Anbau von Blumen – vor allem Rosen. Mit der Zunahme an Farmen stieg auch der Wasserverbrauch von 357 l/s auf 663 l/s. Trotz dieser Zunahme sank die Abhängigkeit von Flusswasserressourcen. Im Jahr 2003 wurden 41%-62% des benötigten Bewässerungswassers während der Trockenzeit den Flüssen entnommen. 2013 waren es noch 10-31%. Dafür stieg der Verbrauch von Grundwasser und Speicherwasser um je 15%. Um die Auswirkungen der kommerziellen Gartenbaufarmen auf die Abnahme des Februarabflusses zu beurteilen, wurden vier Flüsse – Naro Moru, Burguret, Teleswani, Timau –in der Periode 1981-1990 (bevor die erste Farm im Studiengebiet eröffnet wurde) bis zur Periode 2003-2012 (etablierter Sektor) untersucht. Der Beitrag des kommerziellen Gartenbausektors zur Minderung des Februarabflusses ist je nach Fluss unterschiedlich. Grund ist das Vorhandensein (oder das Fehlen) von Wasserspeichern, die den Farmen zur Überbrückung der Trockenzeit dienen. Die Verfügbarkeit von alternativen Wasserquellen ist eines der wichtigsten Elemente für das Fortbestehen der Produktion auf kommerziellen Gartenbaufarmen, und somit für die zuverlässige Belieferung der Kunden in Europa.

Abstract

Mt. Kenya serves as a natural water tower within a savanna-dominated environment. The semi-arid and arid lowlands northwest of the mountain are highly dependent on the perennial rivers that flow from it. Hence, pressures on rivers in the upper reaches put a direct strain on downstream users. Major water users located in the foot-zone northwest of Mt. Kenya include the commercial horticultural companies, which began establishing themselves in the area in the 1990s. These enterprises produce vegetables and flowers for export markets, operating on perennial irrigation schemes. With increased water demand, the potential for conflicts over water allocation grows, demanding careful management and negotiation of river water use during dry season. Therefore, the present study analyzes the development of the commercial horticulture sector northwest of Mt. Kenya and determines its impact on river water resources of various tributaries of the Ewaso Ng'iro in order to provide a better understanding of this actor-category. A previous master thesis written by Roland Schuler (2004) concerned itself with this same topic, covering the period from the sector's foundations in 1991 until 2003. This follow-up study covers the subsequent decade from 2003 to 2013. Conducting expert-interviews with the concerned horticulturist enabled the analysis of four main research foci: the inventory and structure of the commercial horticulture sector; the factors of change influencing its development; the sector's impact on river water resources; and its socioeconomic influence on the region. The study shows a continuous growth of the commercial horticulture sector: the number of farms operating in the study area increased from 28 to 35 covering a total area of 1385 hectares (ha) in 2013 compared to 1085 ha in 2003. Moreover, there has been a major shift from vegetable crop production to floriculture, especially roses. Regarding water use, the calculated dry season water use of the total sector has increased from 357 l/s to 663 l/s. Although water use has increased, reliance on river water has decreased. In 2003, 41%-62% of the total irrigation water necessary in the commercial horticulture sector came from rivers; in 2013, river water accounted for just 10-31% of the sector's total dry season water requirements. Storage water and groundwater grew increasingly important to the horticulture sector during this time, with the usage share of each rising by approximately 15%. In order to assess the impact of the commercial horticulture sector on river water, the depletion of four rivers – Naro Moru, Burguret, Teleswani, Timau – was analyzed during a ten-year period before commercial horticulture started in the study area (1981-1990), compared to a recent ten-year period when commercial horticulture was well-established (2003-2012). The impact that commercial horticulture has had on local river water abstraction varies widely, influenced by the availability (or absence) of water storage facilities and groundwater availability. Currently, alternative water sources are the most important factor in the continuity of commercial horticulture production in the study area, and thus, in the reliable supply of customer demand in Europe.

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Abbreviations

ACP	African, Caribbean, and Pacific countries
ASAL	Arid and Semiarid Lands
CDE	Center for Development and Environment
CETRAD	Center for Training and Integrated Research on ASAL Development
C1 to C25	Codes for commercial horticulture companies interviewed during the field survey 2003
EAC	East African Community
EPA	Economic Partnership Agreement
EU	European Union
EUR	Euro
Ex-USSR	Former countries belonging to the Union of Soviet Socialist Republic
E1 to E30	Codes for commercial horticulture enterprises interviewed during the field survey 2013
FAO	Food and Agriculture Organization
FPEAK	Fresh Produce Exporters Association of Kenya
GPS	Global Positioning System
GSP	Generalized Schemes of Preference (trade arrangements)
HCDA	Horticultural Crops Development Authority
KCC	Kenyan Cooperative Creameries
KFC	Kenya Flower Council
KES	Kenyan Shilling
KNBS	Kenyan National Bureau of Statistics
Ltd.	Limited
LWF	Laikipia Wildlife Forum
MKGG	Mount Kenya Growers Group
MoWD	Ministry of Water Development (Kenya)
MRL	Maximum Residue Levels
NL	Netherlands
PTA	Preferential Trade Agreement
TSB	Tender-stem Broccoli
UK	United Kingdom
URAA	Uruguay Agreements on Agriculture
US	United States of America
USA	United States of America
VAT	Value Added Tax
Wdem	Dry season water requirements of commercial horticulture calculated according to the *Demand Based Estimate*
Wemp	Mean dry season water use of commercial horticulture either specified in interviews or calculated based on interview specifications
WRMA	Water Resource Management Authority
WRUA	Water Resource User Association
WTO	World Trade Organization

Part I: Introduction and Theory

The first part of the thesis introduces the research problem (chapter 1), its objectives, and questions (chapter 1.1). Chapter 2 briefly describes the study area in order to give a sense of orientation. Subsequently, this first part delves into the theoretical background of the research of sustainable development and sustainable resource use (chapter 3.1), and the approach of actor orientation (chapter 3.2). Furthermore, chapter 3.3 briefly analyzes the global agro-industrialization processes and resulting emergence of agribusinesses in order to place the studied commercial horticulture enterprises in the global market system. The final chapter of this first part, chapter 3.4, provides an overview of the current state of research.

As a simplification, this study uses male descriptive terms throughout the text. The two female interviewees are thus included when using the male term.

1. Statement of the Problem

Since Kenya's independence in 1963, the Upper Ewaso Ng'iro Basin, located northwest of Mount Kenya, has experienced many far-reaching transitions. The high plateau (Laikipia Plateau) and the foot-zone of Mount Kenya, characterized by their large-scale properties, had been part of the so-called White Highlands during colonial times. After independence, they were opened up to African settlement (Kiteme et al. 2008, 18). A steady stream of agro-pastoralists from the high potential, but overpopulated, farming areas on the southern and northern sides of the mountain began to immigrate to the Upper Ewaso Ng'iro Basin, where they worked on smaller, subdivided plots of the land. A massive land use change from extensive ranching to small-scale mixed farming ensued (Wiesmann et al. 2000, 12). This influx of agro-pastoral smallholders led to a considerable intensification of agricultural production, as well as general population growth, noticeable in the extension of urban centers and the increasing development of tourist resorts. Beginning in the 1990s, some of the remaining larger farms transformed into highly technical, export-oriented horticultural companies. These farms operated on perennial irrigation schemes, and thus became another important stakeholder for the management of water resources (Wiesmann et al. 2000, 12). This range of developments, including land use change from extensive ranching to small-scale mixed farming, substantial immigration, growing urban centers, new tourist resorts, and year-round horticultural production, all contributed to a robust increase in freshwater requirements (Gichuki et al. 1998; Kiteme et al. 2008; Wiesmann et al. 2000).

As a result of these transitions and increased water demand, the Ewaso Ng'iro and its tributaries are continuously depleting (Wiesmann et al. 2000; Notter et al. 2007). This is especially problematic for the lower reaches of the river system, as water availability along the course of the river is highly varied. The upper reaches of the Ewaso Ng'iro Basin receive high mean annual rainfall due to the natural climatic gradient, whereas the lower parts traverse semiarid and arid environments, such as the Samburu plains, which have a much drier climate. As these lowlands experience low and irregular rainfall patterns, the Ewaso Ng'iro River constitutes a key natural resource for downstream pastoralist populations, wildlife, and related tourism. The availability of water in these areas becomes even more problematic during dry seasons as the water demand in the foot-zone of Mount Kenya increases: 60-95% of the river water available during dry season is abstracted upstream, some of it from unauthorized intakes. In the lowlands, the median decade river flow of the Ewaso Ng'iro dropped significantly during the driest month of the year, February, from 9 m^3/s in the 1960s to 0.9 m^3/s in the 1990s to 0.58 m^3/s in 2000, and the river dried up completely in several years, including 1984, 1986, 1991, 1994, 1997, and 2000. Since the year 2000, the dry season river flow has been reduced to a trickle and barley ever reaches Archer's Post in the lowlands (Liniger et al., in press). The increased water scarcity aggravates the ability of different populations to earn a livelihood. This includes the agro-pastoralist smallholders on the Laikipia Plateau that struggle with limited land resources and highly variable semi-arid conditions, and the pastoralists that must adapt to the historical loss of complementary pastures in the upper reaches of the basin. As demand for water increases, the potential for conflict over water use grows, often manifesting itself in surrogate conflicts of class and ethnicity within communities (Wiesmann et al. 2000, 12–13). Hence, the careful management and negotiation of river water use, especially during dry season, needs to be a priority in order to defuse conflicts over water (Liniger et al. 2005, 163). The successful introduction of mandatory Water Resource Users' Associations (WRUAs) along different tributaries of the Ewaso Ng'iro assisted in allocating water resources and mitigating water conflicts. However, managerial challenges remain, and not all of the WRUAs are strong enough to significantly influence present developments in the basin (Aeschbacher et al. 2005, 155). Providing a better understanding of the different stakeholders and their water use patterns helps to tackle this managerial challenge.

The commercial medium- and large-scale horticultural farms are important and powerful actors with a vested interest in the negotiations of river water resource use. As large water users, they often receive immediate blame from smaller water users when water becomes scarce during dry seasons. The role of these enterprises and their impact on river water resources has been investigated previously in a master thesis written by Roland Schuler (2004), covering the period from the sector's beginning in the 1990s through 2003. Schuler's research showed that the horticultural sector in the study area developed rapidly during this time. At the beginning of the period, the sector was dominated by vegetable production intended mainly for British supermarkets, and subject to great seasonality. This seasonality had great consequences for local river water resources: market demand for Kenyan vegetables in the UK is generally highest during the European fall and winter, from October to March, which largely concides with the study area's dry season when river water resources are already pressured by other stakeholders (Schuler 2004, 4). In order to evaluate the impact of the commercial horticulture farms on the Upper Ewaso Ng'iro North River Basin, Schuler (2004, 153–155) analyzed, over a period of 40 years, the median February low flow of four of its tributaries (Naro Moru River, Burguret River, Teleswani River and Timau River) on which several riparian farms were located in 2003. Schuler's analysis identified two main findings: first, that the impact of medium- and large-scale commercial horticulture enterprises on median February river flows varied greatly across rivers. This could be related to the availability of water storage; without water storage, the massive water demand of riparian horticultural farms during dry season executed full pressure on the river's low flow, greatly impacting the February river flow of the respective rivers (Teleswani River and Timau River). Second, for three of the four rivers, it was clear that they began depleting before the establishment of commercial horticulture in the study area. This indicates that other stakeholders, such as expanding urban centers, intensified small-scale agricultural production by agro-pastoralists, and new tourist resorts, must have contributed to the depletion of the February river flow of these rivers. As a conclusion, Schuler (2004, 153–155) states that even in the period from 1993 to 2002, when horticultural enterprises started to settle and develop in the area, the depletion of the median February river flows could not be singularly attributed to this sector. Hence, the medium- and large-scale commercial horticulture farms cannot alone be responsible for the water scarcity during dry seasons. Still, the potential pressure on river water during dry seasons from riparian horticulture farms without floodwater storage is immense (Schuler 2004, 155). At the end of Schuler's fieldwork in 2003, the sector was still growing rapidly, and by now has certainly changed in extent, structure and production. These developments must be assessed to provide a better understanding of the actor category 'Commercial Medium- and Large-Scale Horticulture' within the topic of water management, in order to contribute to a more detailed picture of water use and related conflicts in the Mount Kenya highland-lowland-system.

1.1. Research Objectives and Research Questions

The objective of the study is to analyze the development of the commercial horticulture sector northwest of Mount Kenya from 2003 to 2013 and determine how these changes impact the river water resources of the tributraies of the Ewaso Ng'rio in the Upper North River Basin. To successfully provide a better understanding of this sector, this follow-up study is structured along four focal sections that concide with the research objectives, each dealing with specific research questions. However, of these four sections, the primary focus is on section (3) Impact on River Water Resources.

(1) Inventory and structure

The first section provides an updated inventory of the commercial medium- and large-scale horticultural enterprises in the study area. This includes the number of companies and farms, their location, and information about their current activities. This section acts as a basis for the subsequent section on the development of the sector. Guiding research questions are:

- How many companies are operating a horticultural business on how many medium- to large-scale farms in the study area? How has this situation evolved since 2003?
- Where are the medium- and large-scale horticultural farms located in the study area?
- What are the major horticultural crops produced on the medium- and large-scale farms in the study area? How has this developed since 2003?
- For what markets is the commercial horticulture sector producing? How is horticultural production of the sector in the study area affected by this specific market orientation? How has this changed since 2003?
- How is the medium- and large-scale horticulture sector structured in the study area in terms of area under horticulture and production volumes in 2013? What other structural features characterize the sector today? How has this evolved since 2003?

(2) Development of the commercial horticulture sector 2003-2013

This second section analyzes how the commercial horticulture sector developed from 2003 to 2013. It describes the factors and conditions that dominated the development of the medium- and large-scale commercial horticulture sector northwest of Mount Kenya during the last decade.

- How did the sector develop from 2003 to 2013 in the study area? Can specific trends be identified?
- What are enabeling (pre)conditions and triggering factors of these developments?
- What are the limitations and constraints in the sector’s development?

(3) Implications for river water resources

The third section describes the water use of the medium- and large-scale horticulture farms in order to assess the sector's impact on river water availability during dry seasons, and to a lesser extent, the sector's impact on water quality. In addition, it investigates the medium- and large-scale horticulturists' opinion on water-related conflicts in the study area. Guiding research questions are:

- How much water do the commercial horticulture farms use during dry seasons, when water resources are scarce and under the most pressure in the Ewaso Ng'iro North River Basin?
- How much of this dry season water use is abstracted from tributaries of the Ewaso Ng'iro River for irrigation purposes of the commercial horticulture sector?
- How has the commercial horticulture sector affected the dry season river flow of the Ewaso Ng'iro? Is there a clear attribution of decreasing dry season river flow to the irrigation practices of the medium- and large-scale commercial horticultural farms?
- What strategies have been implemented to save water or increase efficiency on the different medium- and large-scale farms since 2003?
- How has commercial horticulture affected the water quality (e.g. pesticides or pollution)?
- Are the commercial horticulturists aware of water-related conflicts in the study area, and, if so, are there any mitigating strategies? What conflict-mitigating strategies of medium- and large-scale horticulture companies are possible in the study area? How has this situation evolved since 2003?

(4) Socioeconomic influences of the sector on the region

The fourth, and final, section aims to provide insight into the sector's socioeconomic influence on the region by evaluating selected parameters such as employment and both influences on and direct investments in the public community surrounding the farm. Since these statements are bound to the views of the interviewed target groups, a concluding elaboration upon the socioeconomic influences is impossible. Guiding research questions are:

- How many people does the commercial horticulture sector northwest of Mount Kenya employ on medium- and large-scale farms?
- What are the terms of employment, including wages?

- How, and in what way, do the interviewed horticulturalists estimate the sector's influence on the surrounding communities?

- Do medium- and large-scale horticulture companies support the surrounding communities? If so, in what ways, and what are the horticulturists' motivations to support communities?

2. Location and Description of the Study Area

The study area is situated within the Ewaso Ng'iro North Basin, which is part of the Mount Kenya highland-lowland system. The basin is located to the north and west of the mountain and encompasses an area of roughly 220'000 km^2 from the peak of Mt. Kenya (5199 m) to an average height of 1000 m in the Laikipia Plateau and the Samburu Lowlands (Kiteme et al. 2002, 332). The upper basin of the Ewaso Ng'iro North stands as a reference point for the study area. It is approximately 15'200 km^2 in size and covers 6 percent of the Ewaso Ng'iro North drainage basin, representing 2.8 percent of the total land area of Kenya. Administratively, the area of the basin falls under six counties (Laikipia, Meru, Nyandarua, Nyeri, Samburu, and Isiolo) and three provinces (Rift Valley, Central, and Eastern) (Gichuki 2002, 113). However, the visited horticulture farms are all in Laikipia County, Meru County, or Nyeri County.

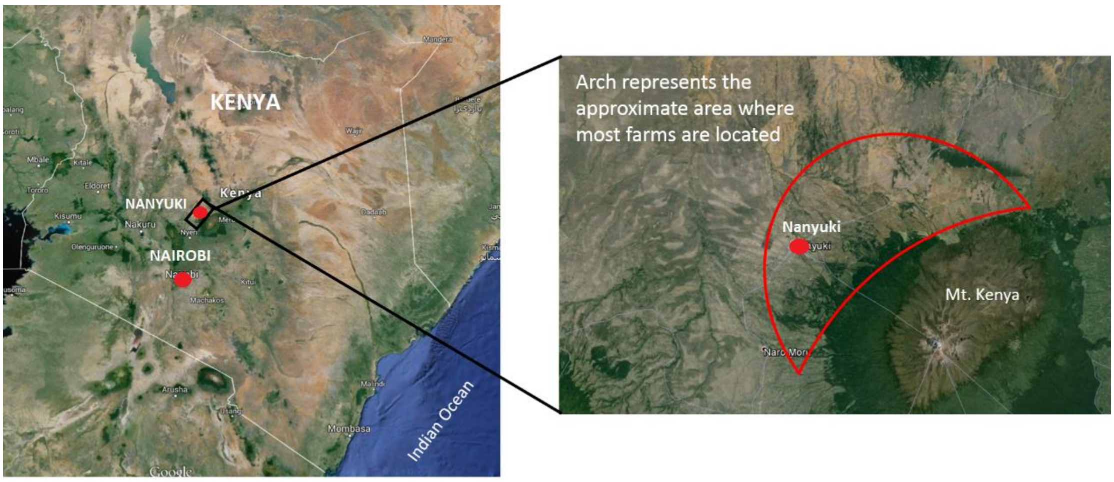

Figure 2.1: Approximate location of the study area NW of Mt. Kenya. (Source: Google Earth, own modifications)

Due to the great natural gradient, the basin traverses seven ecological zones: (1) the afro-alpine (above 3500 m above sea level), (2) the upper mountain slopes (2200–3500 m a.s.l.), (3) the lower mountain slopes (1900–2200 m a.s.l.), (4) the volcanic highland plateau (1700–1900 m a.s.l.), (5) the highlands on basement complex (1700–1900 m a.s.l.), (6) the hills and scraps (1200–2500 m a.s.l.), and (7) the lowlands (800–1200 m a.s.l.). In the humid to semi-humid upper mountain slopes, mean annual rainfall can reach 1000–1500 mm, while in the arid lowlands it can be as low as 350 mm (Gichuki et al. 1998, 16). The elevation and orientation of topographical features have a strong influence on these rainfall patterns. Four characterizing seasons can be distinguished: (1) the long rains from mid-March to mid-June that provide 29–40 percent of annual rainfall, (2) continental rains from mid-June to mid-September that mainly grace the western edge of the basin, with diminishing importance in the northern and eastern edges, (3) the short rains from October until December, and (4) the dry season beginning in January that ends mid-March when the long rains recommence (Gichuki 2002, 115–117). The short rains are especially important in arid zones, contributing 50–60 percent of mean annual rainfall in these areas. However, not all the areas experience three rainy seasons. Almost all the studied farms fall into ranges that receive bimodal rainfall, as illustrated in Figure 2.2. The red circle shows the approximate location of the various visited farms within the bimodal long rains–short rains regime.

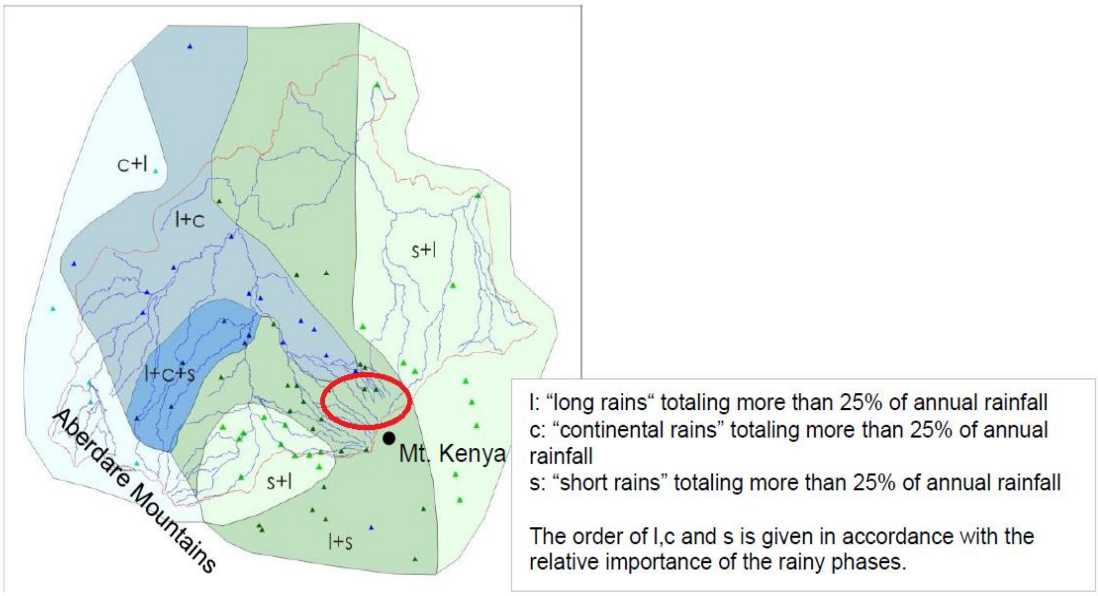

Figure 2.2: Rainfall regimes in the study area NW of Mt. Kenya (Source: Gichuki et al. 1998, 17).

Most of the commercial medium- and large-scale horticulture farms are located between 1700 and 2500 m a.s.l. on the upper and lower mountain slopes, as well as in the highlands of Laikipia County. Therefore, they are part of important ecological interactions within the Upper Ewaso Ng’iro North Basin where depleted river water resources in the upper reaches of the system have great consequences on downstream users. Their effective influence on river water resources is discussed more thoroughly in chapter 10.

3. Theory and State of Research

The following chapter reviews the theory of sustainable development and sustainable resource use with an actor-orientation according to Wiesmann (1997). It also goes into detail around the global agro-industrialization process and the resulting evolution of agribusiness, in which commercial export horticulture played a part.

3.1. Sustainable Development and Sustainable Use of Resources

The vague definition given by the *World Commission on Environment and Development* states that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, 37). Wiesmann (1997, 203–206) further specified the WCED definition, arguing that this is a normative concept that includes elements of the socio-political and sociocultural spheres. Hence, specific target values must be defined. However, these target values "always reflect a standard established by society" (Wiesmann 1997, 204). Thus, in order to achieve sustainable development, the means and method by which an individual or society sets the standards for these specific targets is of crucial importance. Furthermore, the term 'sustainability' needs to be associated with a scale of values; as Wiesmann said, "sustainability will only make sense in a context of social and political evaluation of a specific set of circumstances, and will accordingly be concerned with maintaining values of the long term" (Wiesmann 1997, 207). These scales of values are set within three different areas: socioeconomic systems, sociocultural systems, and ecological systems. Wiesmann (1997, 207–209) has succinctly summarized the core target values associated with the three systems mentioned above:

1) *Economic sustainability* is an indicator to determine the values that define basic material security for all members of a particular society. It also takes into account other factors including economic growth, the potential for economic development, diversity of economic activity, and more. All these aspects relate to overall economic goals, such as long-term economic survival. Hence, in terms of target values, economic sustainability does not refer to the ecological sustainability of economic activities.

2) *Sociocultural sustainability* is concerned with individual cultural, spiritual, and political potential for development as well as the preservation of diverse sociocultural values.

3) *Ecological sustainability* is mostly associated with the conservation of natural resources and ecological stability.

Although the different scales of value of sustainable development can be looked at individually, they are not independent of one another. The promotion of sustainable development in one dimension will always cause changes in values on the other scales; the different types of changes occur simultaneously through a complex series of relationships (see Figure 3.1). These changes may conflict with each other. In particular, the ecological sphere is prone to experience negative changes due to positive changes associated with economic sustainability. In summary, this indicates that sustainable development is a gradual process that cannot be absolute: a sociopolitical process of consensus building is necessary where each interest group weighs and argues its understanding of desired forms of economic, sociocultural, and ecological sustainability. Choices in favor of one option over another for gradual sustainable development are, according to Wiesmann, greatly influenced by (1) power structures and vested interests, (2) the measurability and sensitivity of different scales of values, and (3) the potential for sustainable resource management represented by scales of values (Wiesmann 1997, 209–210).

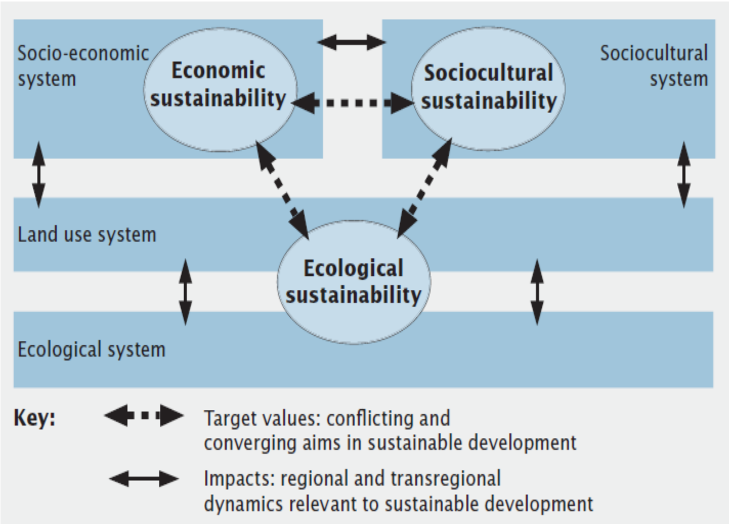

Figure 3.1: The 'magic triangle' as a normative appraisal of sustainable development embedded into a system of human-environment interactions.

(Source: Wiesmann et al. 2011, 22 adapted from Wiesmann 1998)

Though the concept of sustainable development is rooted in the ecological dimension, the economic and sociocultural scales of values often receive more attention. This detriment results from a lack of advocacy for ecological values in the public arena. It also stems from the fact that reference values and indicators linked to economic and sociocultural sustainability have a stronger, immediate impact on society. Measures in these two directions are more likely to provide quick evidence of change, either positive or negative, offering a more easily actionable demonstration of value than do their ecological counterparts. Consequently, economic and sociocultural policy often overrides environmental policy (Wiesmann 1997, 210–211). In this vein, the ecological sustainability of the Upper Ewaso Ng'iro North River Basin is highly vulnerable and prone to problems, as it is part of a highland-lowland system (B. P. . Kiteme et al. 1998, 45). The concern is not with the natural ecological change and variation, but with the human-induced change on scales of values established to evaluate the ecological sustainability. This, in turn, relates directly to the use of natural resources:

> "Human-induced ecological change is rooted in **direct or indirect use of natural resources, whether such resource use is intentional or not**. Resource use thus has a decisive influence on ecological sustainability. If resource use is to be sustainable, natural resources must be used in such a way that long-term ecological target values are maintained. The ecological dimension of sustainable development is thus directly related to sustainable resource use." (Wiesmann 1997, 211).

Although resources are used within a definable area, the resultant ecological impact may diffuse to other, unforeseeable locations. However, one can only assess and understand these ecological impacts in a specific spatial-ecological context; this requires the implementation of measures to promote sustainable resource use in the respective and specific regional context (Wiesmann 1997, 211). Thus, in order to attempt an enhancement of ecological sustainability, it is necessary to define the scales of values for the use of natural resources within a specific spatial-ecological context; in this case, the study area. According to Wiesmann (1997, 213–214), there are four different levels of scales of values within the ecological dimensions, distinguished in descending order of magnitude, each overlapping with the other levels: (1) the ecological system, (2) natural resources, (3) natural potential, and (4) utilized potential. Only the 'natural potential' level fulfills the requirement of including an "adequate number of socially negotiable target values applicable to the ecological dimension of sustainability" (Wiesmann 1997, 214), and it is therefore apt to describe the scales of values in sustainable use of resources. In its definition, 'natural potential' differs from 'natural resources' because of "its relation to a particular **social and historical context**" (Wiesmann 1997, 216). Hence, it loses the arbitrariness and unlimited dimension of the conceptions of 'ecosystems' and 'natural resources' to describe contextually "all components of nature considered useful or valuable by a certain society at a certain point in time" (Wiesmann 1997, 216), making it an adequate level of reference to determine scales of value within the ecological dimension. Two types of natural potential involved in specific development policy and practice are identifiable: (1) specific natural potential, meaning natural potential at the local level embedded into a sociocultural situation, and (2) general natural potential, meaning natural potential as defined scientifically by western industrial societies and most often embraced by national elites and influential development organizations. Although the latter is often predominant at the practical level, the former is equally important since both notions exist within a sociocultural context. The specific and general natural potential may overlap in some areas, while other aspects are clearly distinguished by the unique characteristics and elements contained in one, but not present in the other (Wiesmann 1997, 217).

Consequently, that natural potential, specific and general, functions best in order to establish numerous scales of values within the ecological dimension. By grouping the components of both specific and general natural potential, Wiesmann (1997, 218–219) differentiates four general types that can be used to establish scales of values to evaluate the sustainable use of natural resources:

1) *Production-oriented natural potential* includes the features and components of nature that are both part of either the specific or the general natural potential, and connected to the production of goods. This may include soil fertility or growing conditions related to water availability. Most components are considered simultaneously as general and specific natural potential, and are only differentiable by the (sometimes widely) varying degrees of importance accorded to them.

2) *Physiological natural potential* describes those components of nature that have an effect on the physical well-being of humankind. Quality of air and drinking water are typical examples. The difference between general and specific natural potential is evident, as above, in the significance accorded to each component.

3) *Sociocultural natural potential* comprises those components of nature that have a sociocultural value, such as the cultural and religious significance of objects (e.g. trees) or historically and culturally important sites, monuments, and the aesthetic value of landscapes. In this case, there is a clear difference between the general and specific natural potential: sociocultural values are rarely perceptible in the general natural potential and often hidden behind production-oriented and physiological values, whereas, especially in rural societies, sociocultural values are dominant in the specific natural potential and incorporate the production-oriented and physiological values.

4) *Intrinsic ethical natural potential* aims to describe the right of species of plants and animals to exist without any direct relation to humankind, although they may be components valued by humankind. This contrasts with the three previous types of natural potential, which all contain inherent links to human life and society. The intrinsic ethical value of nature is generally more prominently associated with the general natural potential because modern science has replaced "integrated, site-specific viewpoints that internalize nature – which are frequently found in particular sociocultural aspects of the specific natural potential" (Wiesmann 1997, 219), with more analytical and objective modes of perception of nature. This, alongside the substantial loss of biodiversity caused by Western industrial societies, causes some to suggest that the intrinsic ethical natural potential is a form of compensation to the modern, industrialized world.

Regardless, using either specific or general natural potential as a reference quantity to assess the sustainable use of natural resources at the regional level can be problematic in three different ways according to Wiesmann (1997, 219–221):

1) **The dimension of time:** General and specific natural potential are both directly related to human society and culture. Thus, they change with the ongoing cultural, economic,

social, technical, and ethical changes in a society. Therefore, in the future, both general and specific natural potential will be valued differently than in the present. These future values cannot be predicted; if this were not the case, one could use the specific natural value of a region to determine its scales of values. To overcome this plight and in order to attempt to estimate how natural potential will be valued in the future, Wiesmann (1997, 219–220) proposes to use both specific and general natural potential to establish scales of values to appraise sustainable use of natural resources. This broader range of scales is more likely to offer a useful account of the future values of natural potential than a range defined solely by specific or general potential. Hence, resource use is sustainable if it does not cause long-term depreciation in value to either the specific or the general natural potential.

2) **The dimension of space:** Due to the effect of ecological interactions, resource use in a particular region may be responsible for changes in the natural potential elsewhere. Water problems in highland-lowland systems constitute a suitable example for such trans-regional impacts of resource use, since upstream water use may severely affect downstream water availability. Therefore, both regional and trans-regional changes in the general and specific natural potential must be assessed when trying to evaluate the sustainability of natural resource use.

3) **The problem of balance:** Human resource use influences the different scales of value in myriad ways. For example, while certain types of use can enhance production-oriented natural potential, the sociocultural natural potential may depreciate at the same time. This prompts questions of balance between positive and negative fluctuations in value. By introducing the term of 'weak sustainability' (Foy & Daly 1989, cited in Wiesmann 1997, 220), which states that enhanced value on one scale can compensate for depreciation on another, degrees of sustainable resource use become recognizable, instead of seeking to define sustainable resource use in absolute terms. Nevertheless, there is a need to observe the positive and negative fluctuations in value, as well as for society to address them, especially if depreciation in either natural potential is irreversible and therefore, perhaps unfeasible to balance negative changes with positive ones.

In view of the above considerations, Wiesmann (1997, 221) states that resource use "[…] may be considered sustainable in a regional context if it does not lead to long-term depreciation on scales of values derived from specific and general natural potential, either within or outside of the region in question." However, this constitutes a strict definition of sustainable resource use, and is difficult to apply adequately to reality. By focusing on degrees of sustainable resource use and integrating the principle of balance, the definition becomes practicable:

> "The degree to which resource use is sustainable in a regional context is a function of the extent to which a society is willing to strike a balance between negative and positive fluctuations in the values of specific and general natural potential." (Wiesmann 1997, 221)

This definition encompasses the different scales of values of specific and general natural potential, while allowing a balance between their positive and negative fluctuations according to the interpretations of each community, society, or culture.

3.2. Actor-orientation

As outlined above, sustainable resource use connotes a subset of the framework of sustainable development and its three components of sociocultural, economic, and ecological sustainability. The word 'use' in sustainable natural resource use implies human action and, therefore, social processes, which embed themselves in those three dimensions of the 'magical-triangle'. Hence, it is of utmost importance to consider the humans actually using and managing these natural resources, as they are an important part of the solution:

> "Considering the general societal change in the direction of participation of the individual subjects in the definition of societal rules and regulations in general, as well as the management of resources in particular, classic top-down, technocratic resource management, based on scientific and expert knowledge and fixed broad acceptance, has become inadequate. […] there is a shift from technological solutions of problems (mostly defined by experts) to the rationales, knowledge, and visions of those concerned […]. […] The increasing scarcity of natural resources, as a result of the growing needs of the human population and the growing interlinkages of human activities in the process of general globalisation, renders management issues highly complex. […] Besides the growing number of conflicts between the different resource users owing to scarcity, there is a greater potential for conflict due to the increasingly negative environmental impacts of unsustainable resource use strategies. The burden that the affected – the 'losers' – have to bear is growing, to the benefit of the 'winners'. Conventional resource management approaches do not include appropriate instruments for compensating such external costs […]."(Flury et al. 1998, 97–98)

This citation describes comprehensively why the focus must be on actors in order to achieve sustainable resource use. Therefore, "the experience and know-how […] of actors, e.g. resource users, are being recognized as being at least as relevant as expert knowledge […]." (Flury et al. 1998, 98). The study area is a classic highland-lowland system in which sustainability problems arise within the context of inadequate water resource management, as water use in one zone immediately cascades into zones at lower altitudes and affects communities in the lower reaches of the system. Hence, according to (Kiteme et al. 2008), the main problem obstructing sustainable water use in the Upper Ewaso Ng'iro Basin is rooted in socioeconomic dynamics and land use transformations. In particular, the virtually boundless water demand from immigrant smallholders and the need for large quantities of irrigation water from the fast-growing medium- and large-scale horticulture sector present sources of conflict in water resource management

(Kiteme et al. 1998, 93). Thus, the present study adopts an actor-orientation model towards the actor category of medium- and large-scale horticulturists, as well as their development, actions and functions, and role in regional development. In so doing, the study enhances the knowledge base on medium- and large-scale horticulturists and contributes to the understanding of the actor category's role with respect to socioeconomic and ecological sustainable regional development.[1]

3.3. Agribusiness and Agro-industrialization

Commercial horticulture is a subordinate category of agribusinesses, which in turn is interdependent with the processes of agro-industrialization. Agribusiness is understood as "all the parties involved in a vertical system of aliment production and distribution such as suppliers of agricultural inputs, producers, processors, distributors and the ultimate consumer [= commodity chain]"[2] (Austin 1974 cited in Schamp 1987, 54). The Harvard Business School in Boston, Massachusetts, first introduced the term 'agribusiness' in order to capture the phenomena of increasingly specialized agricultural schemes that were becoming increasingly businesslike, either abandoning core agricultural activities or carrying them out separately from the farm (Schamp 1987, 54). Some examples include the outsourcing of seed and fertilizer production and separated processing, storage, preservation, and delivery of products from basic farming (Encyclopædia Britannica 2014a). There are two categories of agribusiness companies: on one side, the 'direct agribusiness' companies that include all levels of the production chain mentioned in the definition above. These large agricultural companies most often directly engage in the production of agricultural goods on farms and plantations in developing countries. They are not unlike completely vertically integrated, multinational food companies from the colonial period (Schamp 1987, 54). On the other side, indirect agribusiness companies describe multinational companies that outsource their agricultural production. However, they still maintain control over production through consulting contracts, exclusive rights to buy the produce, or by contracting farmers (Schamp 1987, 54).

Agribusinesses arose after World War II as a capitalist form of agriculture. Specialization and mechanization allowed a division of the production steps and, subsequently, a rationalization of production procedures. Consequently, the industrialization of agriculture and the resultant emergence and development of agribusinesses must be understood as an important and integral

[1] For further reading please consult Wiesmann's (1997) habilitation treatise Sustainable Regional Development in Rural Africa: Conceptual Framework and Case Studies from Kenya which proposes a detailed framework to conceptualize actor-orientation and its different components.
[2] Original in German: "[…] die Gesamtheit aller an einem vertikalen Nahrungsmittelsystem Beteiligten: vom Input-Lieferanten über den Erzeuger, den Verarbeiter, den Verteiler bis hin zum Endverbraucher"

element of the agro-industrialization process. At the same time, the process of agro-industrialization would not exist without agribusinesses, since "an increasingly integrated global economy causes established agribusiness firms to look increasingly to foreign suppliers and customers in order to improve profitability" (Reardon et al. 2000, 195). According to these authors, agro-industrialization can be defined as a related set of three changes:

> "(1) the growth of agroprocessing, distribution, and farm-input provision activities off-farm […]; (2) institutional and organizational change in the relation between agro-industrial firms and farms, such as increasing vertical coordination; and (3) concomitant changes in the farm sector, such as changes in product composition, technology, and sectoral and market structures […]" (Reardon et al. 2000, 196).

Many low- and middle-income economies experienced rapid agro-industrialization during the 1990s. The commercial horticulture sector northwest of Mount Kenya is no exception to this development, and must be seen within the wider principles of international trade, globalization, and development (Reardon et al. 2000, 196). According to the classic theory of trade and its subsequent theorem of international division of labor, "[…] the reason why it pays countries to trade is the existence of different relative or comparative costs in the production of different goods. So long as each country possesses a comparative advantage in at least one activity, it pays to specialize in that activity and engage in trade […]" (Grimwade 2000, 32). In this vein, developing countries show a strong comparative advantage in agricultural production, particularly in labor costs, compared to industrial countries. This has led to a long history of agricultural production in developing countries intended for international markets, starting with the export of primary commodities such as coffee and cocoa, and later shifting in the mid-1980s to high-value crops, such as fruits and vegetables (Maertens et al. 2012, 475). In order to link the phenomena of globalization, agro-industrialization, and development, Reardon and Barrett (2000, 196–197) propose a conceptual framework (see Figure 3.2) showing the factors that influence agro-industrialization and their effects on development indicators. The leftmost column is the starting point for the feedback loop, and describes meta-trends common in both developed and less-developed countries, such as income growth, urbanization, market-oriented economic reforms, and the rise of modern technology. These meta-trends, in turn, induce changes in the global agri-food economy (column 2). In Kenya, for example, unilateral liberalization efforts have shifted the focus from food self-sufficiency toward opening domestic agri-food markets to considerable international competition. Concurrently, many organizational and institutional changes within the agri-food economy have ensued (reduced state regulation, globalization, new contractual arrangements between firms and farms). These, associated with increased competition, closely link to the swift technological changes within the different aspects of agricultural production (farm-inputs, information and transport technologies, processing, storage, and inspection of activities). These broader patterns of the first two columns show that "[a]groindustrialization is both an agent of and a response to globalization and induced institutional and technological change" (Reardon et al. 2000, 197–198), and they unavoidably influence still-evolving agro-industries in developing countries. Typical examples are the increased concentration in agro-industrial sectors and an increase in the average size of processing com-

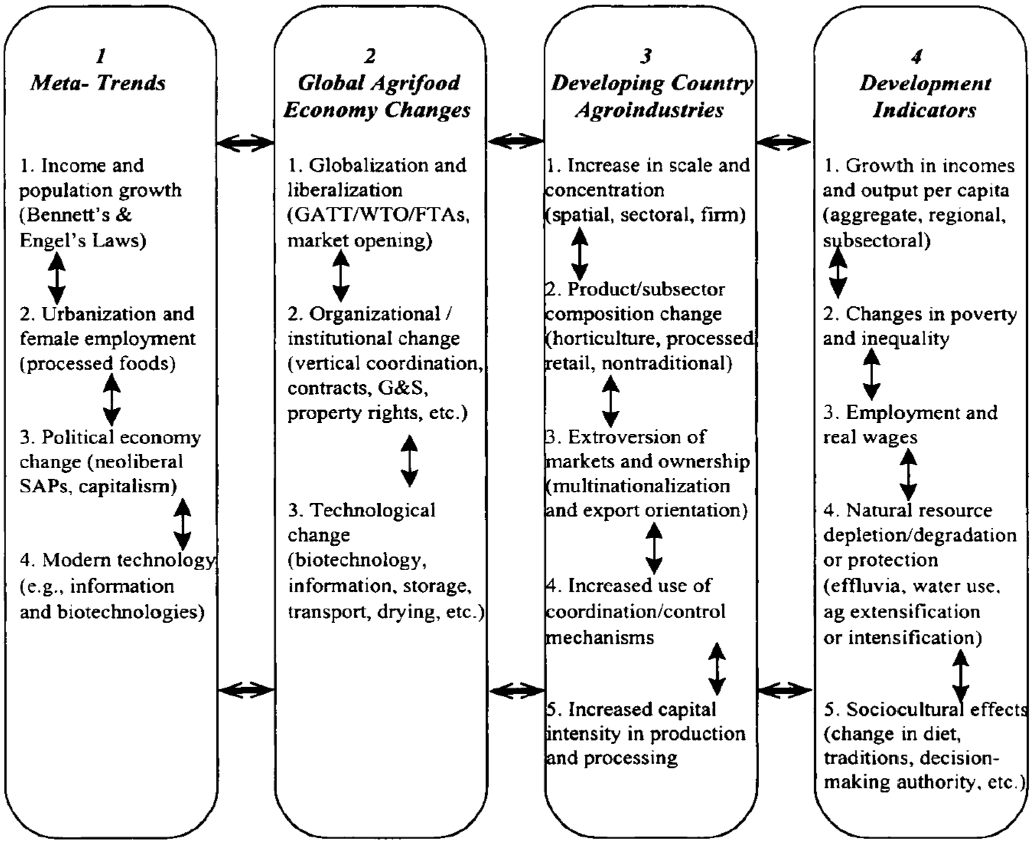

Figure 3.2: Flow diagram showing links among globalization, agro-industrialization, and development. (Source: Reardon et al. 2000, 197)

panies, while smaller and traditional farms hardly manage to reap available economies of scale. As a consequence of these various processes, product composition shifts toward those subsectors in which developing countries own a comparative advantage, such as horticultural products, processed foodstuffs, and non-staple products. Simultaneously, the agri-food chain experiences a sharp increase in the value-added share of processing and distribution, including in non-traditional raw and processed agricultural exports. This relates closely to the rapid multinationalization of off-farm aspects of developing countries' agri-food systems, in which foreign entrepreneurs and firms deliver private, modern input supply and post-harvest processing and distribution providers. With their presence comes not just an increase in capital and finance, but also an increase in the "[…] share of foreign control and/or ownership of domestic firms and the markedly increased presence of multinational firms in the agrifood sectors of most middle-income countries" (Reardon et al. 2000, 198). Inevitably, all of these changes affect different development indicators, as depicted in column 4. Technological change, increased access to private foreign financing, changes in organizational forms, and institutional arrangements to improve coordination may all fuel growth in output and income per capita. However, the aggregate net gains hide distinct winner and losers, which often result from the ex-ante availability of access infrastructure, the spatial and sectoral distribution of the poor, the nature of the particular technologies introduced, and the indirect effects created by overall economic growth. Furthermore, changes introduced through agro-industrialization can influence the current consumer's welfare by altering the quality and quantity of their diets: positively, this translates into increasing convenience and product variety. However, negatively, it translates into imperiled cultural norms and impoverished small farmers, landless laborers, and artisanal service providers. Finally, changes in production patterns always affect the natural environment, and thus the well-being of future generations in the developing world. Increased use of chemicals and water, as well as the expansion of cultivation into fragile areas, demonstrate possible negative impacts. On the positive side, agro-industrialization may reduce environmental pressures by implementing improved production technologies, or by adopting and fostering the transmission of consumer demand for environmentally friendly production practices. However, the effective consequences of agro-industrialization on the environment, as on poverty and employment, depend considerably on local conditions (Reardon et al. 2000, 196–199). As will be shown in chapters 8 and 9, the commercial horticulture sector northwest of Mt. Kenya started mostly as indirect agribusiness in 1990s. Strict market requirements and competitive markets that demand tight control over production and request accountability of the producer have, however, led to increasing numbers of vertically integrated companies that own their own farms, and therefore fit into the category of direct agribusiness.

3.4. State of Research

The Upper Ewaso Ng'iro North river basin and its tributaries have been the subject of various research papers in the past, especially in relation to water scarcity and water conflicts (Aeschbacher et al. 2005; Gichuki et al. 1998; Gichuki 2002; Kiteme et al. 2002; Liniger 1995; Mutiga et al. 2010; Mogaka et al. 2006; Mutisya et al. 2010; Niggi et al. 2008). This research primarily focused on water shortage in the highland-lowland system between the northern and western slopes of Mount Kenya and the surrounding lowlands. The establishment of mandatory water user association has helped to mitigate resulting conflicts between the different water users, but managerial challenges remain (Ehrensperger et al. 2005; Kiteme et al. 2002; Nyaboro 2010; Wiesmann et al. 2000). Moreover, additional transformations, including both environmental effects like climate change and land use conversions and larger changes, such as the incorporation of Kenya into the globalized food market, have negative impacts on the availability of water resources in the study area (Kiteme et al. 2008; Notter et al. 2007).

The export-oriented commercial horticulture companies in the study area represent major water users due to their perennial irrigation practices. Commercial horticulture, in general, is a fast-growing sector in Kenya. Correspondingly, different scholars have produced much scientific literature about its various impacts and development over the last twenty years. Many have concentrated on the resulting social influences, mostly analyzing potentially negative outcomes (Barrientos et al. 2005; Dolan et al. 2000; Dolan 2002; Dolan 2004; Dolan 2005a; Dolan 2005b; K'Aol et al. 2011). Others focused their research on the economic effects of this growing sector; they tend to view the impacts of the commercial horticulture sector for the Kenyan society from a more positive perspective (Chandra 2006; English et al. 2004; Lenné et al. 2005; Mutuku Muendo et al. 2004). Next to this scientific literature, there is a plethora of newspaper articles on the subject of commercial horticulture in East Africa. The British newspaper *The Guardian*, in particular, has given the matter great importance. These brief journalistic pieces mostly adopt a very critical view on the subject of export-oriented medium- and large-scale horticulture, and they emphasize the potentially destructive effects of those businesses on the environmental and socioeconomic spheres (Lawrence 2003; Lawrence 2011a; Lawrence 2011b; Seager 2007; Smithers 2011; Stewart 2009; Vidal 2006).

Many of these research and newspaper articles link the role of the commercial horticulture sector to the problem of depleting water resources in Kenya. One article (Ulrich 2014), in particular, looks at the commercial horticulture sector in Laikipia, which coincides largely with the study area of this study, and focuses on the implications for rural livelihood. However, no research has focused directly on the development of the commercial medium- and large-scale horticulture sector on the northwestern slopes of Mount Kenya and its impact on river water resources since Roland Schuler (2004) first conducted his master thesis on the topic. Ultimately, all previous research analyzed the sustainability of commercial horticulture regarding specific socioeconomic, sociocultural, or ecological issues. In this vein, the present study utilizes the concept of sustainable development as an overarching theoretical framework, according to Wiesmann (1997). Simultaneously, it adopts an actor-oriented perspective toward the medium- and large-scale horticulture sector in the study area in order to understand the rationale behind resource use and management in terms of sustainable development (see chapter 3.1 and 3.2).

Part II: Methodology

Part II delves briefly into the research design in chapter 4, before detailing the operational definitions of the thesis that should clarify concepts and prevent any misunderstandings in reading or interpretation. Chapter 5 then elucidates the various processes of data acquisition and the corresponding methods, such as the expert interviews held with managers or owners of the farms and how the various farms were mapped. In order to guarantee comparability to Schuler's first study in 2004, I applied the same methodology here. Chapter 6 describes the actual data analysis: it begins with the qualitative content analysis, and continues with the descriptive statistics used for quantitative data analysis. This chapter does not discuss details on how water data was calculated, however, this is covered with the results in chapter 10.2.

4. Research Design

When Schuler prepared his thesis in 2002, there was very little information available on the commercial horticulture sector in the study area. As a result, he designed the research according to explorative principles. In a scientific process, explorative studies precede explanative and descriptive ones by creating hypotheses and theories that can subsequently be tested through explanative studies (Bortz et al. 2006, 356). Hence, exploration can be defined as the "[…] more or less systematic collection of information on a study subject, which prepares the formulation of hypotheses and theories."[3](Bortz et al. 2006, 354). This does not mean that explorative studies operate without theory. Variables included in the process of data collection that provide the topical focus are based on implicit or explicit assumptions and theories. With explorative studies, this theoretical knowledge is not sufficiently developed in order to be operational and to allow statistical hypothesis (Bortz et al. 2006, 356). Therefore, this follow-up study adopts the same explorative character as Schuler's study, since there is no other, newer information on the medium- and large-scale horticulture, undermining the formulation of statistically sound hypothesis. Concurrently, because this study uses the same interview guide (see chapter 5.3), it seemed appropriate to keep the explorative character of the research. There are four strategies of exploration: (1) theory-based strategies that compare and evaluate existing theories to generate new ones, (2) method-based strategies that reflect new methods to explore new hypotheses, (3) empirical-quantitative strategies that use quantitative data to construct new ideas and

[3] Original in German: „Mit Exploration ist das mehr oder weniger systematische Sammeln von Informationen über einen Untersuchungsgegenstand gemeint, das die Formulierung von Hypothesen und Theorien vorbereitet."

hypotheses, and (4) empirical-qualitative strategies that use qualitative data to identify previously neglected phenomena, interdependencies, and processes (Bortz et al. 2006, 358–389). The present study aligns with the last two categories, empirical-quantitative and empirical-qualitative. This allows for the generation of baseline data on the medium- and large-scale commercial horticulture sector in the Upper Ewaso Ng'iro North River Basin.

4.1. Operational Definitions

Before delving into the finer details about data acquisition and data analysis, and in order to prevent misunderstandings, the core concepts of 'medium- and large scale,' 'commercial horticulture,' 'horticulture,' 'horticultural crops,' 'outgrower,' and the 'target group' are clarified and defined.

(1) 'Medium- and Large-Scale' – 'Commercial Horticulture'

The terms 'medium-scale' and 'large-scale' refer to the area under horticulture on a single farm, and do not include any parts of the farm that are used for other purposes (e.g. cereal and/or dairy farming). Therefore, a commercial horticulture farm must cultivate a minimum of four hectares, as inductively defined by Schuler (2004, 14), to constitute a medium-scale farm. This lower boundary effectively excludes the plentiful, local small-scale horticultural enterprises from the scope of the study. The boundary between medium-scale and large-scale is set at eight hectares. This line was also drawn by Schuler (2004, 14) based on various definitions given in literature. For the sake of comparison, the present study uses these same definitions of the terms 'medium-scale' and 'large-scale.' 'Commercial horticulture' is a synonym for 'medium- and large-scale' horticulture farms as defined above.

(2) 'Horticulture' and 'Horticultural Crops'

Generally, horticulture defines the raising and tending of garden crops such as vegetables, fruits, and ornamental plants. The origin of the word comes from the Latin *hortus* (garden) and *colere* (to cultivate) (Encyclopædia Britannica 2014b). Although the term covers all forms of garden management, it most commonly refers to intensive commercial production in which horticultural crops are produced for sale and profit (USAD 2014). Horticulture production aims to cultivate plants for either food (pomology and olericulture) or ornament (floriculture and landscape horticulture). Pomology describes the cultivation of fruit and nut crops, whereas olericulture deals with herbaceous plants like carrots (edible root), asparagus (edible stem), lettuce (edible leaf), cauliflower (edible flower), tomatoes (edible fruit), and peas (edible seed). Floriculture produces flowers and ornamental plants; in the present case floriculture consists of mostly cut flowers, but other areas focus on pot plants and greenery. By contrast, landscape horticulture broadly defines plants for the landscape such as lawn turf and nursery crops (shrubs, trees, climbers) (Encyclopædia Britannica 2014b). In his thesis, Schuler (2004, 15–16) developed an operational definition of 'horticulture' and 'horticulture crops' based on selected definitions from literature, inputs from the conducted interviews, and a group discussion with experts at the Jomo Kenyatta University of Agriculture and Technology (JKUAT):

> "Horticulture is a branch of agriculture which is concerned with the production and the marketing of vegetables, flowers, and fruits for nutritional, medicinal or esthetic purposes."(Schuler 2004, 16)

'Horticultural crops' are defined as follows:

> "Horticultural crops are vegetables, flowers, and fruits which require high inputs in terms of labor and other production factors, which are perennial or biennial crops and have a short shelf life and, in the case of vegetables, are harvested immature."(Schuler 2004, 16)

Combining these two definitions results in the exclusion of potatoes, though some experts consider it a horticultural crop. In the case of maize, a subtle delimitation exists: whereas mature maize is not considered a horticulture crop, its premature crop of 'baby corn' or 'sweet corn' is fully accepted as a horticultural crop (Schuler 2004, 16). As for the definition of 'medium- and large-scale commercial horticulture', this study adopts Schuler's definition in order to guarantee comparability, but also because of its preciseness and clarity.

(3) Definition of Target Group

Similar to the above, the target group for data collection remains consistent with that from Schuler's study and is defined as "[t]he persons in charge of the medium- and large-scale horticulture companies or farms, respectively, being the owners and/or the general managers of the farms" (Schuler 2004, 16). This is because the study, then and now, focuses on different topical fields (e.g. water use, development of the farm, employment conditions) and the above-defined persons were considered the most competent to answer the different questions and provide the expected data. Schuler added a second target group of 'experts' during his field stay, which he met for a group discussion in Nairobi in order to fill a knowledge gap around the development of the general Kenyan horticultural sector, as well as the local environment. This exercise was not repeated for the present study. There are two reasons for this decision: first, the mentioned knowledge gap in 2003 was mostly due to numerous changes in management of the different farms and the ensuing loss of historical knowledge about the sector in the study area. In 2013, circumstances on most of the farms were much more stable. Hence, most interviewees provided a satisfactory amount of information on the respective farm and the development of the sector in the study area, relativizing the benefit of additional expert interviews. The second reason is of a purely practical nature: since the field stay encompassed just two months, a tight time schedule was necessary in order to conduct interviews at all of the farms in the area. Thus, time did not permit the organization of a group meeting with experts in Nairobi. Furthermore, I deemed the available online information on the Kenyan horticultural sector through the Horticulture Crops Directorate (HCD) and the Kenyan Flower Council (KFC) of sufficient quality to gain an understanding of the Kenyan horticultural sector, although it could not fully replace in-depth discussions with experts.

(4) Outgrowers

Outgrower schemes, also known as contract farming, broadly define binding agreements through which a company ensures its supply of agricultural products from either individuals or groups of farmers. A vertical integration of the agricultural value chain results from these coordinated commercial relations between producers, processors, and traders, meaning that one single center controls all stages of agricultural production and subsequent merchandising. Specific outgrower schemes can adopt various forms, differing in each partner's input and management. Outgrower schemes are seldom instigated to explore local market opportunities without committing to large amounts of capital and other investments for various companies (Felgenhauer et al. 2011, 2). Commercial horticulture in the study area started with outgrower schemes before investors became confident enough to establish their own farms and companies on-site, as described shortly in chapter 9 and in Schuler's thesis (2004, 75–77). The biggest challenge for outgrower schemes is knowledge of partners and gaining and building trust. Fear of exploitation on both sides must be managed in order to structure a successful business venture. Most often, this is achievable with long-term engagements from both sides and extensive dialogue between all the stakeholders (Felgenhauer et al. 2011, 2–3). Chapter 8.3 details the evolution of the outgrower scheme in the study area.

5. Data Acquisition

Data collection took place in five distinct steps. First, it was necessary to locate the commercial horticultural farms and ensure access to the field. Second was the conduction of expert interviews with current medium- and large-scale commercial horticulturists in the study area. Third, either GPS data of the farm location was collected, or the interviewee directly mapped out the farm's location on pre-printed A3 details of the study area. Fourth, two former medium- and large-scale commercial horticulturists were interviewed. Finally, in-depth discussions with actors involved in the regional water resource management were held.

5.1. Inventory – Locating Commercial Horticulture Farms

The first objective of the present study is to provide a full inventory of all the medium- and large-scale horticulture farms located in the study area. Based on Schuler's (2004, 59) inventory, I conducted an internet search of the different companies to assess if they were still operating in the area and if they had an online presence with available contact information. This was a superficial process, which only yielded information on some of the farms. Once in the study area, I complemented the list with the help of researchers from the Center for Training and Integrated Research in ASAL Development (CETRAD) who had in-depth knowledge of the study area. Tom Traexler of Rural Focus, a local engineering and development consultants firm, provided further assistance. Finally, I located the remaining farms by asking the farmers about adjacent farms that carried out horticultural activities. I then visited these farms to determine if the farm fulfilled the prerequisite of 'medium- to large-scale horticulture company'; if so, I scheduled an appointment for a further farm visit and interview. This procedure led to a complete list of all the medium- and large-scale commercial horticulture farms in the study area.

5.2. Access to the Field

Obtaining access to the field in qualitative research is typically very complex because interactions with other human beings are usually intense and demand great involvement from both the subject and the researcher. Qualitative research is often a source of irritation to the studied social system and can cause defensive reactions, complicating access to the field (Flick 2010, 142–146). Therefore, gaining access to the different farms and obtaining interview appointments with farm managers or owners was a major challenge of the proposed fieldwork, largely because of its 'irritating' character. In addition, commercial horticulturists in the study area have a reputation of being private and reluctant to share any kind of information with outsiders, as experienced by many researchers at CETRAD. There are two very valid reasons for this: first, market competition is fierce on the regional, national, and international levels. Second, the Kenyan horticulture sector has often experienced negative portrayals in the press, which faulted farm managers and owners for exploiting workers and polluting, wasting, and overusing natural resources (see chapter 3.4). These accusations, whether valid or not, appear as a threat to the horticulturists' business, as consumers react with increasing sensitivity to ethical and environmental issues. Thus, a highly competitive sector and bad press have created a reserved and mistrustful attitude toward strangers. Therefore, getting effective access to the companies and the farms was the most crucial undertaking of this study.

Fortunately, obtaining effective access to the field was easier than anticipated. First, the situation was less tense and reserved than expected. This is, among other things, due to considerable public relations efforts, evident from the internet presence of various farms. This made for a much more welcoming atmosphere than initially presumed. Still, some hesitations prevailed during the subsequent data collection. In order to defuse some of these hesitations and ensure access to the field, a meeting was scheduled with representatives of Rural Focus Ltd., a respected engineering and development consulting firm based in Nanyuki. Rural Focus provides services covering the planning, technical, institutional, and management aspects of water supply and water resource management for several of the horticultural companies in the study area. They kindly supported the research for this study, and wrote a recommendation letter to submit to the different farms in the study area. Concurrently, the director of CETRAD, Mr. Boniface Kiteme, also wrote a recommendation letter outlining the scope of the study. These letters confirmed the true scientific motivation of the research and were crucial components in the process of building confidence with managers or owners of the respective farms, and thus gaining access to the field. The third step was primarily due to fortunate circumstances, but became as important as the recommendation letters. Various horticulturists in the study area are loosely organized in the Mount Kenya Growers Group (MKGG), which meets four times a year. One of these meetings took place two weeks into the fieldwork, and through an invitation from James Mwangi from the Laikipia Wildlife Forum (LWF), which was conducting research on aquifers for the MKGG, I had the opportunity to participate in the meeting. I met most of the flower farmers and was able to present my research to them. They expressed their support and, after the event, the chair of the MKGG send out an e-mail to all members (some were not present at the meeting) expressing their support and advising them to anticipate contact from me requesting an interview. In this manner, I made immediate contact with twelve of thirty horticultural companies in the area. The others, as described in chapter 5.1, I visited directly and made an appointment on-site. Sometimes, it was necessary to visit a farm more than once to get in touch with the correct person who could then arrange for an interview. This led to almost complete coverage of the medium- and large scale commercial horticulture farms in the study area. Two farms, one flower-producing and one vegetable-producing, refused completely to participate in the research. Nevertheless, apart from these two, the field survey covered a complete inventory count and set the total sample size of 30 companies on 35 farms (including the ones not interviewed).

5.3. Interviews with Horticulturists

A single interview guide directed all of the interviews with medium- and large-scale horticulturists (see Appendix IX). The guide had been developed by Schuler (2004, 19), and was modified slightly for the present study to accommodate the decade-long time lapse. This aligned with the aforementioned quintessential value of direct comparability to the first study. Schuler designed the guide as an expert interview guide. Expert interviews aim to discover the respondent's special knowledge and experiences about a certain field of action, which result from the actions, responsibilities, and obligations of their specific functional status within an organization or institution (Flick 2010, 214). To be an expert is a relative term, usually ascribed by the researcher according to the leading research questions. Thus, an expert has special 'expert knowledge' that is related to a special professional or vocational field. Expert knowledge includes *technical knowledge* about details on operations, laws, and more influencing the field of study; *process knowledge* about routines, specific interactions, and processes that is acquired through the direct involvement of the expert; and *explanatory knowledge* about ideas and ideologies, or subjective interpretations of relevance, rules, and beliefs made by the expert. Expert interviews not only elicit information about the expertise but also investigate implicit and tacit knowledge about maxims of action, rules of decision-making, collective orientations, and social patterns of interpretation (Bogner et al. 2002, 46). There are two types of experts with different kinds of expert knowledge: (1) those with operating knowledge, who are responsible for or have knowledge about the development, implementation, or control of solutions, strategies, and policies, and (2) those with contextual knowledge, who have privileged access to information about groups of persons or decision processes (Meuser et al. 2002, 76). In the present study, experts of the first category were interviewed: the single horticulturist's knowledge about his company or farm, as well as his knowledge about the sector's development in the study area, make him an expert on medium- or large-scale commercial horticulture. As with every method, the expert interview has flaws. The greatest challenge is often gaining access to the proper expert. In the present study, the question of who to interview was not the primary issue, so much as gaining access to the field (see chapter 5.2). A second common problem is time. Compared to other types of qualitative interviews, expert interviews must have a compact design while also allowing the interviewee to explain complex processes. Thirdly, the question of trust between the interviewer and interviewee is of great importance, especially when sensitive information regarding competition and markets is at stake. It is crucial to acknowledge that expert knowledge is not neutral, and interaction effects between the interviewer and interviewee are high. Furthermore, experts are part of the societal debate in their given setting, and different power relations often play a vital role (Flick 2010, 217–218).

Detailed information on the methodology for creating the present interview guide can be consulted in Schuler's thesis (2004, 19–21). However, the structure of the interview guide along two defining dimensions bears repetition here. First, the interview guide combines quantitative and qualitative parts separated only for their distinct data analyses. Second, the interview guide comprises two main topical sections. The first section contains questions about the development of the respective farm in the study area and the development of the medium- and large-scale commercial horticulture sector in the study area. Section two deals with the current activities of each farm in order to create a structured inventory of the sector. Hence, the most promising part of the interview guide takes place first, which was advantageous in case of any sudden time shortcomings on the respondent's side.

During the interviews and the farm visits, additional extensive field notes were taken: for example, descriptions of the environment or information given by junior employees who accompanied the visit on the farm. Both interview data and field notes served as a base for the following data analysis.

The full fieldwork comprised 28 interviews with current medium- or large-scale commercial horticulture farms. I conducted all interviews face-to-face in English, apart from one interview conducted via e-mail. Mr. James Macharia from CETRAD assisted the data collection by giving general advice, sporadically helping to formulate questions, and taking notes. All of the in-person interviews, save one, were tape-recorded. Each interviewee was encoded to guarantee anonymity and confidentiality. Schuler (2004, 16, see footnote 12) encoded respondents as, for example, 'C2,' meaning 'Company number 2.' I encoded them as, for example, 'E2,' meaning 'Enterprise number 2,' in order to avoid confusion with Schuler's data.

5.4. Mapping

During his fieldwork in 2003, Schuler collected GPS positions of the corners of every block under horticulture either by walking around the farm or driving to the different points (Schuler 2004, 23). This approach, although precise, was very time consuming. Today, thanks to Google™ Earth, rather high quality satellite images of the study area are universally available. Thus, before going into the field, I printed various A3 maps of the study area to take to each interview. After completion of the interview, the interviewee charted out his farm on the map. The advantage of this method was its quickness. Additionally, it offered a nice way to wrap up each interview. The downside, however, was inaccuracy. Although some satellite images were precise enough that individual greenhouses and plots were identifiable, others were not. Consequently, the mapping for these farms is not as precise as would be ideal. To verify the location in these cases, I took additional GPS positions with a Garmin™ eTrex 10 GPS. Hence, while the location of each mapped farm is correct, there may be slight inaccuracies in the depicted size or extent. In a second step, the farms were mapped out as polygons on Google™ Earth. I then exported this data as a KML file, imported it into ArcMap (ESRI), converted into a layer, and exported as a shapefile. The shapefile then fed back into ArcMap and, together with two shapefiles containing data about towns and rivers and a digital elevation model (DEM), I created the various maps seen in this thesis. As the goal of these maps is to illustrate rather than to allow further calculations, the slight inaccuracy of some of the farms' size or location was deemed acceptable.

5.5. Interviews with Former Horticulturists

Two additional interviews were conducted with former horticulture farmers who retired from the horticulture business sometime between the first study and the present one. The guide for these interviews was based on that explained in chapter 5.3, mostly eliminating section 2 and adding some questions about the reasons behind their cessation of horticultural activity. Both of these farms were vegetable outgrowers, one medium-scale, and one large-scale. I acquired the interview with the former medium-scale outgrower by driving to the farm and explaining the research to the owner at the gate, upon which she agreed to speak. Contact with the former large-scale outgrower first occurred through email. I believed the farm to still be in the business and found contact information online; however, I was kindly informed that the farm was no longer in the horticulture business, but that the owner would still be happy to participate in an interview. These two interviews gave important information about the more difficult aspects of the business, especially for outgrowers, but also more generally on problems linked to vegetable horticulture crops.

5.6. Interviews with Regional Water Management Actors

Because one of the foci of the study is on the impact of the medium- and large-scale commercial horticulture on river water resources and the potential conflicts water scarcity may entail, I held two interviews with regional water management actors.

The first of these interviews was with an irrigation officer from the Water Resource Management Authority (WRMA) in Nanyuki. WRMA is a corporate body operationalized in 2005 because of the implementation of the 2002 Water Act. Its objective is to ensure rational, effective water resource management and equitable access for various competing stakeholders. It is the lead agency in the management of water across all of Kenya. There are six regional WRMA offices, one of which is located in Nanyuki and covers the Ewaso Ng'iro North catchment (WRMA 2013). The irrigation officer interviewed was an expert on water issues in the area and past water conflict management. The interview guide was an adaptation from the guide for the horticulturist, focusing on general questions about water conflict and water management in the area and suppressing questions that did not apply. His knowledge about water conflict blended into accounts from the interviews with horticulturists, corroborating their statements. Extensive notes were taken during this interview in lieu of a tape recording.

The second interview was with Mercy Kendi, a project manager of the Ngusishi Water Resource User Association (WRUA). The WRUA Ngusishi formed in 1998 as a self-help group for those depending on the Ngusishi River. This came after a series of conflicts between the different users upstream, midstream, and downstream. In 2002, the WRUA officially registered with the help of WRMA after WRUAs became mandatory based on the 2002 Water Act. Today, it is one of the best functioning WRUAs in Kenya, comprising 16 water projects in an area of 104 km^2 (Ngusishi Water Resource Users Association 2013). This session was designed as a narrative interview (Flick 2010, 227). An initial question prompted the interviewee to launch into a narration of how and why the WRUA Ngusishi was established, followed by a recounting of the various development steps, difficulties, successes, and more, augmented by clarifying questions. The main difficulty with narrative interviews is to formulate the initial question broadly enough but also specifically enough, for the narration to be relevant to the research question (Flick 2010, 229). The initial question asked was:

> "I would like you to tell me how and why the WRUA Ngusishi was established and how it has evolved since its early days. Maybe it would be best to start with the why, why the WRUA was formed here in 1998, then you could go on about the difficulties and successes encountered since then up until today, and how it is structured now. Take your time; if you want to recount specific details, please do so, as everything you deem important is interesting to me."

Another problem with narrative interviews is that not everybody is a natural narrator. Also, the Western culture has predominant narration schemata that may not apply to other cultures (Flick 2010, 235). This interview was tape recorded, alongside to note-taking. Most of the insights from this interview were previously covered during the interview with E32, a former horticulturist and one of the founders of the WRUA Ngusishi. However, this interview enabled a visit of the WRUA's common intake, which provided a very interesting perspective.

5.7. Validity of Data

As discussed in chapter 5.2, the topical focus of the study is somewhat sensitive because horticulturists in the study area have experienced various accusations ranging from polluting and wasting natural resources to exploitation of their workers. Simultaneously, competition in the business is fierce and consumers in Europe react increasingly sensitively to ethical and environmental issues in the production process of their consumer goods. Agribusinesses all over the developing world feel pressure from these various factors, as can be seen in the increasing number of labels they must carry and comply with in order to stay competitive. It is no different for the medium- and large-scale commercial horticulture sector northwest of Mount Kenya. There is a risk of developing poor reputations, or even exclusion from the market. Therefore, some horticulturists may have glossed over their activities regarding the more sensitive issues discussed (e.g. water use, water sources, and daily wages). This problem might have even increased if the interviewee expected this study to become a scientific reference for public relations, reasoning that the sounder his answers, the more favorable the sector would appear, and the better the company's image would seem to consumers.

Such constellations obviously create problems regarding the validity of the data, especially for sensitive topical sections. I was very much aware of this problem; however, unfortunately there is no way to verify the truthfulness of the statements given by methodological interventions. Some of the farms could be visited (accompanied by an employee) after the interview, which mostly took place in the manager's office or a boardroom, and these tours allowed attempts to validate some of the interview data. With 28 interviews of farm managers or owners, the different values, especially on water use, could also be cross-validated within this sample, with attempts to identify and explain spikes.

6. Data Analysis

As the interviews contain both quantitative and qualitative components, a full transcription would only be sensible for the qualitative part. After consulting with the supervisors of the thesis, we decided that a careful re-listening of the interviews, combined with extensive note taking and selective transcription, would be sufficient. Numerical data was extracted during the re-listening and prepared for separate quantitative data analysis.

6.1. Qualitative Data Analysis

The qualitative data was analyzed with a qualitative content analysis according to Mayring (1983), as described by Flick (2010, 409–416). The aim of this approach is to reduce the text material by approaching the material with predefined categories, rather than developing them from the material. Hence, the research questions are clearly defined before starting the content analysis (Flick 2010, 410). The present study has several research questions (see chapter 1.1 for detailed research questions) embedded into different focal sections, which necessitated the formation of categories for the respective qualitative part. The qualitative content analysis is, to various extents, important for chapters 7, 8, 9, 10.4, and 11. There are three different techniques of content analysis:

- *Summarizing content analysis* aims to reduce the material to the contents relevant for the research questions.
- *Explaining content analysis* attempts to enhance the level of comprehension of fuzzy, ambiguous, or contradictory text material by consulting additional context-relevant material.
- *Structuring content analysis* seeks out types or formal structures within the material according to predefined criteria. Thus, the material is structured either by topic, scale, or formally.

The qualitative data analysis for the present study is a mix of the summarizing content analysis and the structuring content analysis. There was a need to reduce the material to content relevant for the respective research questions, while also structuring according to the topical content of the single statements of interviewees (Flick 2010, 413–415). Hence, the material underwent two reductions: first, the selected text material (in this case, verbal) was paraphrased, meaning that all parts of the interview without contents were eliminated, and content-bearing parts were broken down to a uniform register (first reduction) (Flick 2010, 410; 412). From this point, the data for the thesis became text, with the content-bearing parts written out. This data was then inductively codified. A second reduction consisted of grouping similar paraphrases with equal statements or topic. This step allowed for a reduction of the material by eliminating irrelevant material and obtaining a certain degree of generalization on a higher level of abstraction (Flick 2010, 410). The remaining relevant material was then summarized into predefined categories based on Schuler's analysis and the interview guide. Additional categories or subcategories were inductively formatted during the process of extracting and arranging the various respondents' statements. Hence, this led to a complete codification and categorization of the collected data.

6.2. Quantitative Data Analysis

Quantitative data was extracted during the process of reviewing the interviews to prepare for quantitative data analysis. The amount of preparation necessary varied greatly according to the quality of the data received during the interview. Major calculations were necessary for chapter 10. The precise descriptions of calculations are in the same chapter in general terms, and in the respective appendix for each farm. Once the data was prepared, it was processed according to the descriptive statistical methods that "[…] aims at showing the information contained in a set of data as clearly as possible in order to show […] 'the essentials' quickly. Descriptions may be graphic and/or numerical […]”[4](Kromrey 1998, 392). Descriptive quantitative data analysis makes it possible to compare samples and collectives at a glance, and to recognize correlations between attributes (Bortz et al. 2006, 371). By means of Exploratory Data Analysis (EDA), quantitative data can be analyzed graphically in order to gain new insights and ideas into a set of data. Bortz and Döring (2006, 372–376) describe EDA in detail. It is clear from the examples cited there that optical inspections provide much more thought-provoking impulses than mere numerical descriptions.

[4] Original in German: *Die beschreibende (descriptive) Statistik zielt darauf ab, die in einem Datensatz enthaltenen Informationen möglichst übersichtlich darzustellen, so dass ‚das Wesentliche‘ schnell erkennbar wird. Diese Beschreibungen können graphischer und/oder numerischer Natur Art sein.*

Part III: The Horticulture Business

Part III introduces the national Kenyan horticulture business. How did the industry start and develop in Kenya in general? What were the challenges faced by commercial horticulture since the beginning of the 21st century? What is the structure of the industry today? What is Kenya's role in the global horticulture business? Chapter 7 answers these questions, and more.

7. Horticulture in Kenya: History and Present Stage

The horticulture industry in Kenya originated around the year 1900 under the governance of the Imperial British East African Company with experiments on temperate fruits and vegetables. Indians building the Kenya-Uganda railway also introduced Asian vegetables such as chilies and eggplants (Minot et al. 2004, 6). However, the quantities remained modest. It was not until World War II that large-scale horticulture took off in Kenya to supply food to the Allied Forces stationed in North Africa, the Middle East, and East Africa. It began with a wartime dehydrated vegetable scheme; most of the raw material came from small-scale African farmers surrounding the processing facilities (McCulloch et al. 2002, 3–5). After the war, the demand for dehydrated vegetables collapsed again, but the scheme exposed the potential of engaging smallholders in commercial horticulture production. Although smallholders increasingly participated in the production of traditional cash crops such as coffee, tea, and pineapples, horticultural development remained limited during the post-war colonial period. On the eve of independence in 1963, fruit and vegetable exports represented less than 3% of agricultural exports and roughly 0.3% of the total Kenyan export value (Jaffee 1995, cited in McCulloch et al. 2002, 3).

DEVELOPMENT OF THE HORTICULTURE INDUSTRY POST-INDEPENDENCE

Independence brought three significant changes to the Kenyan horticulture industry: first, the land reform launched by the new government bought vast amounts of the land farmed by Europeans and distributed it to thousands of African smallholders. This took place particularly in the western highlands, which largely coincides with the study area. The relatively rich soils and the ideal location of this region offered opportunities for smallholders to engage in horticulture. Second, the creation of the Horticultural Crops Development Authority (HCDA) in 1967 facilitated the coordination of various participants in the industry without directly managing and controlling the horticultural trade. Although this was mostly because of limited staff and resources, even with a larger budget and staff, several researchers have claimed that the fact that the HCDA remained passive probably allowed the sector to develop more rapidly (Kimenya 1995; Harris et al. 2001; Djikstra 1997). Third, after independence, international investments in the Kenyan horticulture sector grew rapidly. In 1965, two years after independence, one of the two Kenyan pineapple factories came under the control of Del Monte (then called the California Packing Corporation) and the largest fruit processor in the world. Del Monte's establishment attracted other international companies to invest into the Kenyan horticulture sector, instigating steady growth of 4.4% per year through 1974. However, the contribution of fruit and vegetables to total agricultural exports remained at less than 3%, as the total industry grew at a rate similar to horticultural exports (Minot et al. 2004, 9–12). Take-off for commercial Kenyan export horticulture started around 1974 as exports increased to US$ 95 million in 1990, at 8.0% growth per year in real terms over the period 1974-1990. During this time, the Kenyan horticultural exports jumped from representing 3% of total agricultural exports to 14%. This was primarily due to the investment by Del Monte in a large-scale pineapple farm and the overall development of the pineapple processing industry to gain independence from smallholders who favored sales to local markets. Thus, the growth in fruit and vegetable exports during the early 1970s came primarily from increased fruit production and export[5]. However, by the 1980s, the driver turned toward vegetable exports. The fall of coffee and tea prices starting in 1978 led to a more intense diversification into vegetables, as they fetched higher commodity prices. Concurrently, demand for vegetables rose as an indirect effect of the expulsion of the South Asian community from Uganda under the regime of Idi Amin. These refugees often resettled in the UK, growing the local Asian community and, therefore, demand for Asian vegetables (McCulloch et al. 2002, 13). Kenya presented itself as an ideal supplier, as it was able to produce year-round because of the favorable climate and already had experience growing Asian vegetables for the local Asian community. Another factor supporting the production of fresh fruits and vegetables was the growth of the Kenyan tourism industry. By 1980, 372,000 international tourists visited Kenya each year. Fresh produce, contrary to canned goods that can be transported from Africa to Europe by ship, require airfreighting. When production volume failed to justify cargo planes, passenger jets provided the means to airfreight Kenyan fresh produce to Europe (McCulloch et al. 2002, 13–14). Cargo jets are of invariable use today, but the tourism industry provided an important stepping-stone for the infant horticulture sector in Kenya. Meanwhile, exporters began to realize the great potential of smallholders to meet growing European demand. By the mid-1980s, roughly 13,000-16,000 smallholders accounted for 40-65% of the supply of French beans, Asian vegetables, mangos, avocados, and passion fruit for export. In particular, fresh and canned French beans became one of the most important horticultural export products from Kenya to Europe. In the beginning, exports remained limited

[5] Pineapple exports in 1977 accounted for 65% of all Kenyan fruit and vegetable exports (Minot et al. 2004, 13).

to European winter and spring months, when domestic production was insufficient. However, lower labor and land costs, combined with climbing demand for year-round supply, resulted in a shift toward obtaining French beans and other vegetables from North Africa and sub-Saharan Africa. Concurrently, beginning in 1974 when Del Monte started to produce their own pineapples, a trend towards large-scale, vertically integrated production began. By the end of the 1980s, Kenya was the leading supplier of fresh vegetables to twelve European countries, and it is still a major supplier to European markets today (Minot et al. 2004, 16–17). Overall, between independence and 1991, Kenyan horticultural exports increased around twelvefold in terms of volume and fortyfold in terms of value (Jaffee 1995, cited in McCulloch et al. 2002, 2).

FURTHER GROWTH FROM SMALL-SCALE TO LARGE-SCALE

The Kenyan horticulture industry continued to grow in the 1990s while simultaneously expanding its range of export crops. Competition from other exporting countries like Côte d'Ivoire, Morocco, Zimbabwe, South Africa, Egypt, and Cameroon also increased steadily. During Schuler's research, the national horticulture industry was the fastest-growing agricultural subsector in Kenya. It made major contributions to Kenyan GDP, and was one of the top three foreign exchange earners in 2003. Hence, the sector rapidly caught up with the traditional leading export industries of coffee and tea during the 1990s. In 2003, Kenya was among the world's top five exporters of horticultural produce (Schuler 2004, 47) and the sector consisted of three main types of export produce: flowers, vegetables, and fruits.

(i) At the beginning of the horticulture industry in Kenya up until 1990s, vegetable produce came primarily from smallholders. However, by the late 1990s, large-scale commercial farms had largely replaced small-scale export production. The exporters often either owned or directly leased these farms to large-scale commercial contracted farmers. This constituted a new development at the beginning of the 21st century: contract farming had traditionally signified the outsourcing of production to small-scale farms. This shifted toward a preference for large-scale outgrowers. This was due to the increasing requirements of consumer markets to ensure production quality throughout the process from planting to shipping. For the exporter, costs are significantly lower if supervision is only necessary over a few large-scale contract farms, rather than a great number of small-scale outgrowers. Thus, smallholders contributed only 18% of vegetable export production against an aggregated 82% from large commercial farms (Dolan et al. 2000, 166). In 2000, five to nine major exporters controlled 85% of the Kenyan vegetable sector. Small to medium-sized export companies struggled to comply with increasing market demand on issues such as label programs, Maximum Residue Levels (MRLs), and crop traceability. Additionally, high investment costs for post-harvest facilities, such as cooling and pre-packing plants, further concentrated the sector around large, capital-intensive companies (FKAB Feldt Consulting 2001, 4).

(ii) Four to five large companies operating with vertically integrated production systems dominated the floriculture sector. Companies were usually also exporters, transporting and marketing their flowers. Although the flower industry started out with open-field low-value crops, this market segment declined already in the 1990s in favor of high-value, high-quality flowers. These, however, require large investments in production facilities, such as greenhouses. Only well-established companies operating on large-scale farms could afford these investments, and hence, the flower sector was concentrated around large, vertically integrated companies (FKAB Feldt Consulting 2001, 3–4).

(iii) Outgrower systems dominated the horticulture fruit sector in the early 2000s. Small-scale contract farmers almost exclusively produced mangos and avocados in 2003, while larger production units conducted passion fruit production. As in the previous two sectors, a few major exporters controlled the fruit production sector (FKAB Feldt Consulting 2001, 4).

In summary, the Kenyan horticultural production of vegetables, fruits, and flowers experienced a concentration in the 1990s and the early 2000s. All three subsectors shifted away from small-scale outgrower systems toward larger production units (Dolan et al. 2000, 166). Simultaneously, smaller companies lost ground in the horticultural business to medium and larger companies (Dolan et al. 2000, 161). The consolidation of the Kenyan horticultural industry went hand-in-hand with the increased importance of food safety certifications implemented by the main consumer markets in Europe (Minot et al. 2004, 22) as illustrated by the following citation:

> "[…] the tightening of the European regulations on pesticide use and the costs of collection output from multiple smallholders appears to be leading to greater production on large farms in which growing conditions can be more carefully controlled. […]" (McCulloch et al. 2002, 3–4)

However, small-scale outgrowers remained important for the Kenyan horticultural sector, as they still produced a considerable portion of export crops. Nonetheless, a few major companies in a highly buyer-driven market environment did the actual exporting. The level of consolidation increased further since most of the exporters engaged in at least two of the horticulture subsectors, e.g. flowers and vegetables.

ONGOING CHALLENGES

At the end of Schuler's fieldwork, the commercial horticulture sector faced new challenges despite its continued growth. This was mostly due to altered consumer demand and the transformation of food retail markets in Europe. These transformations are ongoing processes that still influence the commercial horticulture sector today:

(i) *Rise of supermarkets in the UK:* Between 1989 and 1997, supermarket chains increased their market share of fresh vegetables and fruit from 33% to around 70%. This trend occurred similarly in continental Europe. The rise came as supermarkets bypassed wholesalers and negotiated directly with exporters in Kenya and other countries. In order to protect their reputation, supermarkets started to impose new restrictions and even organize production in developing countries (Minot et al. 2004, 19).

(ii) *Increasing concern over food safety:* European consumers started to become increasingly aware of pesticide residues and their health consequences, a concern that continues to intensify today. In 1990, the UK adopted the Food Safety Act, which obliges food retailers to guarantee that their food is safe. Consequently, many UK supermarkets started to get more involved with their producers and impose requirements, often in the form of certifications or labels, on the food production process. The Minimum Residue Levels (MRLs) of pesticides were of special concern. Supermarkets often control and monitor every step of the commodity chain; as a result, the production of horticulture crops for export in developing countries has become increasingly complex. Additionally, production costs have risen, which further handicaps production (Minot et al. 2004, 20). A common standard for producers of fresh fruit and vegetables outside of Europe is Global G.A.P., which began in 1997 as EUREPGAP, an initiative by retailers and supermarkets in the UK and continental Europe to harmonize their own standards and procedures and develop an independent certification system for Good Agricultural Practice (G.A.P.). EUREPGAP standards aimed to help producers comply with Europe-wide requirements for food safety, sustainable production methods, worker and animal welfare, and responsible water use, compound feed, and plant propagation materials. In 2007, EUREPGAP changed its name to GLOBAL G.A.P., and exists today as one of the world's leading farm assurance programs. All horticultural producers of fresh fruit and vegetables in Kenya must comply with this standard in order to supply European supermarkets and retailers (GLOBAL G.A.P. 2014).

(iii) *Increasing demand for convenience:* Since the end of the 1990s, the demand for prepared fresh vegetables and fruit on the European markets increased steadily. This preparation may include washing, peeling, cutting, pre-mixing, and/or packaging in small, ready-to-eat units. Due to the labor intensity of these activities, exporting countries such as Kenya experience the opportunity of adding value (Minot et al. 2004, 20). One of Kenya's comparative market advantages is, as mentioned before, the low cost of labor intensive economic activities (McCulloch et al. 2002, 4).

Schuler's research ended prior to the onset of some important economic and political challenges in Kenya. Although these are not discussed in detail here, as they would constitute an interesting and substantial research topic on their own, it is important to be aware of them. Primarily, Kenya experienced a period of political instability due to post-election violence in 2008 coupled with adverse weather conditions. These events coincided with the financial crisis and economic recession in Europe, Kenya's main consumer market. Despite these challenges, the horticulture sector continued to grow. Growth during this time came primarily from the floriculture and fruits and nut sector, whereas vegetables decreased in volume due to the adverse weather conditions. Since the flower sector can continue to produce relatively independently of rainfall, as long as the correct infrastructure exists, it is less susceptible to adverse weather conditions than other components of horticulture. Additionally, 2008 constituted the best Valentine's Day sales in history, further boosting production. Furthermore, the floriculture industry responded well following the post-election violence by ensuring that no shipments were lost and that laborers worked extra hours to compensate for the man-hours of displaced workers. In contrast, vegetables are, to a large degree, grown by smallholders and much more subject to adverse climate and political changes. Hence, this might account for the slight decrease (3%) in volume of vegetable production (HCDA 2008, 5). Moreover, despite the global economic downturn, in 2009 the value of Kenya's horticulture exports was an impressive 71.60 billion KES, equivalent to $895 million in foreign exchange. However, it seems that the recession in Europe and adverse weather in Kenya from 2008 took their toll in 2009, and caused an overall fall of 15% in quantity of exports and 3% in value, as expressed in KES. The foreign exchange value in $US dropped by 13%. Again, flowers and fresh fruit did relatively well: flowers accounted for 52% of the KES value of exports in 2009, and thus maintained 2008 export values and volumes. Cut flowers formed 95% of all flower exports, with primary destinations of the Netherlands and UK. In contrast, fresh vegetables accounted for 24% of 2009 exports and suffered strongly from both drought and reduced market demand, resulting in a further fall of 5.5% in exported volumes and values, equivalent to a 14% fall in dollar returns (HCDA 2009, 1). There was a further drop in 2010 volume produced and export value due to problems from the volcanic ash of Eyjafjallajökull in April 2010, and bad weather in December of the same year. However, the sector rapidly recovered in 2011 (HCDA 2010, 3).

KENYAN HORTICULTURE INDUSTRY IN 2013

The agriculture sector is the lifeblood of the Kenyan economy, contributing 30% of total GDP and accounting for 80% of employment, while the horticultural industry is the second most important subsector in the agricultural sector after tea. Currently, the Kenyan horticultural industry produces and exports a great variety of products, grouped in the three main categories of vegetables, flowers, and fruits. In the year 2013, roughly 189 differentiable horticulture crops were exported from Kenya (HCDA 2014). From 1992 to 2013, total export volumes increased nearly fourfold in a rather steady fashion. All three categories contributed significantly to this tremendous growth. However, the floriculture sector showed the most significant volume growth during this period, with a more than fivefold increase compared to a threefold increase in the vegetable and fruit sector. Yet, all three subsectors demonstrated weaker growth in the second decade from 2003 to2013, compared to the period from 1992 to2002. In 2013, the total domestic value of the horticulture sector amounted to 177 billion KES, or approximately 1.5 million EUR, with a total production quantity of 132 megatons (HCDA 2013b, 13).[6]

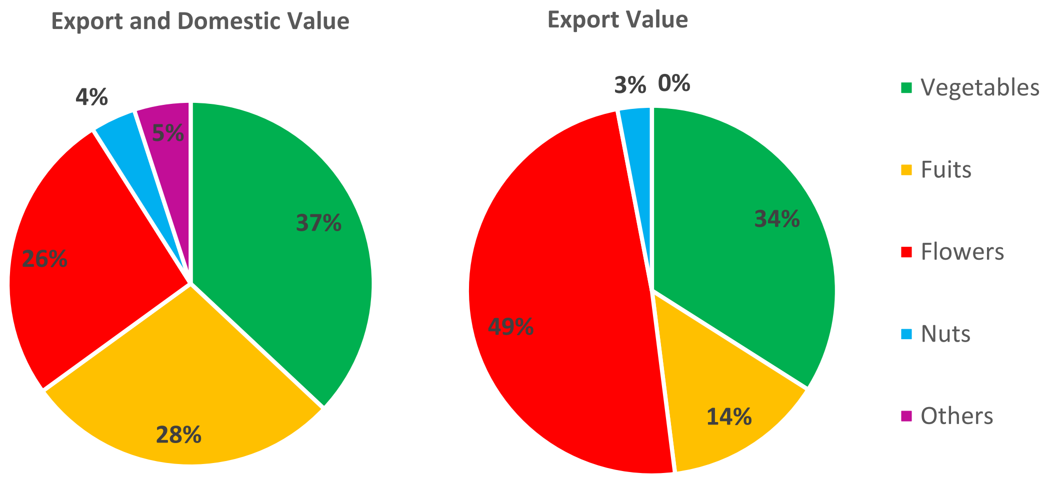

Figure 7.1: Share [%] of horticulture domestic and export values by product (left) and only export values by product (right) in 2013. (Source: HCDA 2013b, 13–14)

[6] 1 KES = 0.008879 EUR on the 29.10.2014 according to http://www.xe.com

Info Box 1: Major Domestic and Export Horticulture Crops


Tomatoes


Potatoes


Cabbage


Garden Peas


Snow Peas


Sugar Snap


Bananas


Mangoes


Pineapple


Stevia


Mint


Rosemary


Peanuts


Coconuts


Macadamia

Various Sources: please consult referenc section.

Info Box 2: Major Export Rose Categories

Varieties: Bi Colors, head diameter 5-7 cm, stem length 50-90 cm

Varieties: Single Colors, head diameter 5-8 cm, stem length 50-90 cm

Varieties: Sprays, small heads, stem length 50-90 cm

Source: www.sunlandroses.com

However, overall exports increased (7% by value and 20% by volume), mainly due to the floriculture sector. As shown in Figure 7.1, floriculture yields a much higher export value than all the other crops, accounting for half of the entire industry by exports. Contrarily, vegetable exportation has experienced a downward spiral, losing 20% of export value and 41% of export volume compared to 2011 and 2012. This is unrelated to climatic and political conditions in Kenya, but results from increased inspection levels on consignments exceeding the set Maximum Residue Levels (MRLs). Hence, an increasing number of exporters suffer denials of service in attempting to export their products (HCDA 2013b, 14). Thus, it is realistic to assume that previous declines in vegetable exports were due not only to unfavorable conditions in Kenya, but also to general difficulties in the market situation. However, domestic demand for vegetables increased in recent years, supporting the continuous growth of this subsector and making it the leader in its overall contribution within the horticultural industry, as shown in Figure 7.1. The impact of commercial horticulture on domestic markets, coupled with demand from upscale urban markets and the rise of Kenyan supermarkets with the resultant economic and social ramifications, is another interesting topic worthy of further study elsewhere. The main vegetables produced in Kenya are exotic vegetables (94% share by value), African leafy vegetables (5%), and Asian vegetables (1%). Potatoes (43% share by value), tomatoes (21%), and cabbages (12%) are the main vegetables produced for domestic markets. French beans (3% share of value), garden peas, snow peas, sugar snaps, and runner beans (2% each) are the main export crops. However, snow peas and sugar snaps both suffered strongly due to non-adherence to set Maximum Residue Levels of pesticides provided by the EU by small-scale farmers. In contrast, French beans do well despite the tight restrictions, since many producers integrated traceability systems in supply, and thus have enabled exporters to monitor chemical use by farmers directly. Other export crops include courgettes, broccoli, and baby corn. Some of these export crops, such as garden peas, are exported as a mixed prepack together with other crops (HCDA 2013b, 14–42).

The main fruits grown in Kenya are bananas (37.6%), mangos (19.6%), pineapples (12.1%), avocados (9.8%), pawpaw (5.4%), oranges (4.6%), watermelon (4.2%), and passion fruit (3.7%). Most fruits are produced for the domestic market. The share for export is concentrated on fresh and/or processed fruits like pineapples, passion fruit, and mangos. The potential of most commercial horticultural fruit crops remains underexploited, especially in terms of processing, where the added value lies (HCDA 2013b, 47–61).

Herbs have been on the rise in Kenya for several years. While they were often categorized alongside spices and medicinal plants, in 2013 the HCDA attributed them their own category. The leading herb cultivated in Kenya is stevia (83% share by value), followed by rosemary (6%), celery (3%), mint, cucri, and parsley (each 2%), and lemon grass (1%). Cucri and Rosemary are herbs grown by small-scale farmers, and have the potential to be grown in ASAL areas (HCDA 2013b, 43–46).

Nuts are another growing subsector of the horticulture industry in Kenya. The leading nuts by value grown are peanuts (54%), coconuts (16%), macadamia nuts (15%), cashews (12%), and Bambara groundnuts (3%). The nut sector faces challenges in high cost of investment, scattered small-scale growers, poor market channels and pricing, frequency of diseases and pests, and malpractice (premature harvesting). Most nuts are produced for export markets, as domestic consumption remains hampered by high prices. However, the government has undertaken revitalization measures such as encouraging the establishment of adequate domestic processing capacities, organizing industry players into associations and business groups, training farmers, and restricting exports of unshelled nuts, which all helped to increase productivity (HCDA 2013b, 62–65).

Sadly, the HCDA figures on flower production are unreliable, since many large flower exporters refused to volunteer data for the HCDA survey in 2013. However, it is clear that floriculture is the leading export crop. Very few flowers are sold on the domestic market; additionally, roses have proved to be the leading crop of the floriculture subsector (HCDA 2013b, 13).

KENYAN HORTICULTURAL INDUSTRY WITHIN THE GLOBAL MARKET

The global horticultural industry is very dynamic and characterized by continuous growth in recent years. Trade is dominated by south-north flows, with producing countries close to the equator and main consumer markets in Europe and North America. Kenya is, together with Colombia, Ecuador, Ethiopia, and the Netherlands, one of the top five flower-exporting countries (Rikken 2011, 3). It is also the second largest vegetable exporter in sub-Saharan Africa after South Africa, and the second largest developing country supplier of horticultural crops to the European Union after Morocco (Muthoka et al. 2014, 121). Markets are exceedingly competitive. In the flower sector, Colombia and Ecuador previously dominated the market segment of high quality, large-flowered roses. However, the quality of African products has increased in recent years, and thus the rivalry between the various producers in a stagnating market grew fiercer. Furthermore, the financial crisis of 2007-08 affected producers heavily, as Colombian and Ecuadorian flower companies dropped their production in recent years. In Kenya, labor and energy costs remain relatively low compared to South American competitors. In addition, Kenyan companies have benefitted from the strong Euro, making their cost in Kenyan Shillings and US Dollars low. Moreover, Kenyans still pay no import duty for exports to Europe. Nonetheless, increased oil prices and economic recession in 2009, coupled with complications from volcanic ash in 2010, resulted in a stagnation of the sector in those years. Since 2011, Kenya has returned to growth (Rikken 2011, 5). Neighboring Ethiopia is a newcomer on the global horticultural business platform: until 2004, the country had no notable flower industry. However, seven years later, Ethiopia can count 1600 hectares of horticultural cultivation, primarily of roses, and the industry has become one of the country's main export sectors. With wages considerably lower than in Kenya, Ethiopia has become a main competitor. However, Ethiopia's industry is still in its infancy, and experienced various growing problems such as lack of adequate pesticide regulations, strict regulations concerning the repatriation of foreign exchange earned on exports, and, above all, lack of experience. The sector suffered severely from the financial crisis. Thus, it is not yet a major threat for Kenya, which is arming itself against rivals by establishing more direct marketing routes and direct sells, and therefore bypassing the Dutch auction (Rikken 2011, 9). Apart from competition with other producers, various other external factors affect the development of horticultural sector worldwide, and thus, in Kenya specifically. Rikken (2011, 19–20) summarizes the main influencing external forces on the global horticultural industry:

(i) *The currency triangle: euro–dollar–national currency:* The relationship between national currencies and other currencies are of great importance for growers. Kenyan producers earn their revenues in Euros, but pay their various costs in US Dollars or Kenyan Shillings. As long as the Euro remains strong compared to those two currencies, the growers profit positively.

(ii) *Climate:* Climate is primordial for the horticultural business. In 2009 and 2010, Kenya experienced long periods of drought and a period of heavy rains. The first resulted in heated discussions of water management, and the second in lower production because of diseases linked to humidity.

(iii) *Oil prices:* Kenyan growers' costs are almost 70% oil-related. Therefore, spikes in oil prices, like in 2008 when barrels sold for US$ 150, have enormous effects on the cost of transportation, chemicals, fertilizers, and packaging.

In sum, the Kenyan horticultural industry is extremely vulnerable to influences of external factors such as currency, oil prices, climate, and the economic situation in consumer markets. Additionally, market constraints are becoming increasingly complicated as worldwide supply grows with new players, but consumption stagnates. Therefore, profit margins for horticultural producers shrink by the year. For such a significant national industry, this is a real concern in Kenya. Furthermore, competition is no longer solely defined by costs and price, but plays out on multiple fronts: standards and certifications such as GLOBAL G.A.P., quality and innovation, and more. Moreover, these aspects are constantly changing and reshaping, making market access in both the present and future an increasingly complex enterprise (Rikken 2011, 25).

Part IV: Results and Discussion

Part IV of the present thesis discusses the results from the 2013 field survey in comparison to Schuler's findings from 2003. They are presented according to the four research goals (see chapter 1.1), starting with the inventory and structure of the sector (chapter 8), followed by its development since 2003 (chapter 9), then going into details about the sector's water use and its impact on river water resource (chapter 10), to finish with some socioeconomic parameters (chapter 11). At the beginning of each results chapter (8, 9, 10, and 11) Schuler's key findings are summarized to give an overview of the situation a decade ago. At the end of each chapter, final insights are summarized and briefly discussed.

The presented data was collected in September and October 2013, and thus, the inventory relates to this time. Each topical section is compared to Schuler's (2004) thesis and his data. Schuler conducted his field survey between February and April 2003, so his inventory therefore relates to April 2003.

The study focuses on the total medium- and large-scale commercial horticulture sector in the study area. In order to ensure anonymity and confidentiality, single company information is aggregated and only made explicit where it is of special interest. Furthermore, all information processed in the following chapter came from these interviews and Schuler's master thesis submitted in 2004, unless specified otherwise. For technical statements, e.g. about growing methods, the respondent's code is given as a source, (e.g. E11).

8. Inventory and Structure of the Horticulture Sector

In 2003, 24 commercial horticulture companies operated on 29 medium- or large-scale farms.[7] The total area under horticulture comprised 1085 ha, with an average of roughly 39 ha per farm. Vegetable production dominated the study area, taking up approximately 94% of the land by production, but Schuler predicted that flower production, which only started in 1997, would expand in the near future. Furthermore, two major companies dominated the sector (C16 and C17), including their contracted outgrowers (C3, C4, C11, C21, and C25), in terms of area under horticulture as well as volume produced and number of employees. Vegetable crops (mostly runner beans and garden peas) were mainly produced for supermarkets in the United Kingdom such as Marks & Spencer, Sainsbury's, and Tesco. This narrow range of customers from an almost unilateral market orientation toward the UK meant that the Kenyan horticultural

[7] One company could not be interviewed in 2003; Schuler subsequently disregarded it from his analysis, setting the sample size at 24 instead of 25 companies, and 28 instead of 29 farms.

sector was highly dependent upon these few supermarket chains. Hence, production experienced great seasonality: primary demand came in the European autumn and winter, from October to March. The greatest commercial opportunity existed during that period, and therefore the sector produced strongly in that time. However, this period corresponds largely with the dry season in the study area (January to mid-March), when there was very little rainfall and river water resources were most pressured (Schuler 2004, 151–152).

The following chapter analyzes how this situation evolved since 2003 and what the main characteristics structuring the sector are today, compared to in 2003.

8.1. Inventory and Structure in 2013

The current approximate area under horticulture in the study area is 1385 ha, on which 30 companies operate on 35 farms with an average of 39.5 ha per farm.[8] Seeing as the total area under horticulture increased by roughly 300 ha since 2003 while the average cultivated hectares per farm remained practically the same, a reduction of average farm size is observable. Concurrently, the total increase in area under horticulture is equivalent to approximately one third of the sector's growth from 1991 until 2003. This slowed growth and the unchanging farm sizes link directly to the shift from vegetable crops to flower crops, which is discussed later in this chapter. In most vegetable-producing farms, the effective cultivated horticultural area differs significantly at different times of the year. This is because most vegetable farms practice crop rotation. During crop rotation, a block of land, e.g. one hectare, is left fallow or cultivated with another crop (either horticultural or non-horticultural) after harvesting. This helps to prevent soil depletion, and decreases potential pest and disease risks.

Total area under horticulture (n=35) [ha]	Approximate mean area under horticulture (n=35) [ha]	Approximate dry season area under horticulture (n=35) [ha]	Approximate rainy season area under horticulture (n=30) [ha]
1385	1236	1343	976

Table 8.1: Areas under horticultural production NW of Mt. Kenya in 2013 (Source: field survey 2013)

Contrarily, roses, most herbs, and fruit trees are perennial crops that remain in the ground for several years. Therefore, the area under cultivation for roses, fruit, and most herbs remains unchanged throughout the year. The mean annual area under cultivation is slightly less than the total available, at approximately 1236 ha (see Table 8.1), because the area under cultivation fluctuates on some farms according to market demand and/or growing conditions. For example, during the rainy season, the total area under horticulture falls to 976 ha because market demand

[8] The area under horticulture includes all land on which horticultural crops are planted at least once a year. Consequently, areas that had been fallow or under preparation to be cultivated during the field survey are also considered areas under horticulture. Therefore, the area under horticulture may be greater than the effective cultivated horticultural area at a given time of the year.

is lowest in this time during the European spring and summer. This value comes with qualifications, as the total sample is n=35, but during the rainy season the sample is only n=30. During dry seasons, the approximate area under horticulture nearly corresponds with the total area under horticulture. The difference of 42 ha has two sources: two farms reduce their area under cultivation during the dry season by a total of 12 ha between them. The remaining 30 ha result from another farm indicating a greater total area under cultivation for the dry and rainy seasons, as well as the mean annual, which could be due to fallow land or the farm’s packhouse or other infrastructure taking up space. Additionally, the approximate mean area under horticulture must sometimes be calculated according to the general assumptions as specified in chapter 10.2 because the interviewee did not provide a specific number; this may be a source of errors.

Comparing the current environment to that in 2003 (see Figure 8.1) illustrates two interesting facts: first, while seasonality in terms of area under cultivation is still present, it is much less pronounced than it was a decade earlier. In 2003 the area under horticulture during rainy seasons, when market demand is lowest because it concurs with European spring and summer and competes with European production, drops by almost 50%. In 2013, there is still a drop, but it is significantly less substantial, at roughly 30%. Second, in 2003 the mean annual area under horticultural cultivation consists of about two-thirds of the total area under horticulture, whereas in 2013 it amounts to almost 90%. Therefore, production not only increased in terms

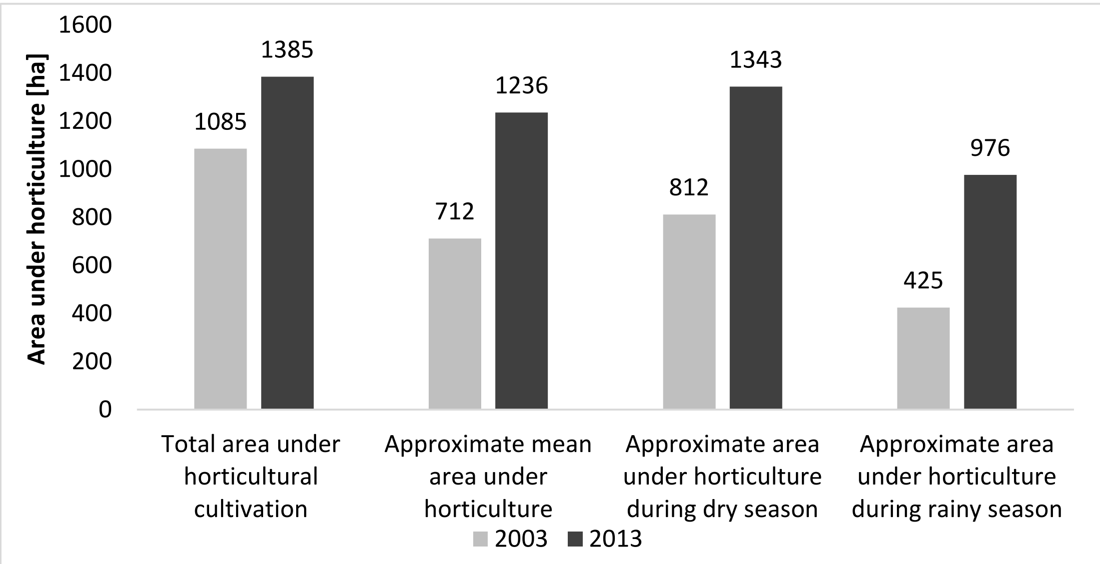

Figure 8.1: Area under horticulture NW of Mt. Kenya during different seasons in 2013 and 2003. (Source: Schuler 2004, 59; field survey 2013)

of area, but also in terms of intensity. The reason, once again, is the shift from vegetable farming to flower farming, namely roses. Roses require much less area to cultivate while maintaining profitability. At the same time, they are perennial crops, and thus the area under cultivation is not subject to seasonality. It also takes some time until a rose plant produces appropriately; although first roses flower after approximately four months, they are often of poor quality. Only after two to three years do rose plants reach maximum production (E11). Hence, reactivity to market demand is lower than for vegetables. Figure 8.2 clearly illustrates the shift from a sector dominated solely by vegetable horticulture crops to the rise of floriculture. The area under cultivation for vegetable horticulture crops did not diminish massively, but the increase in hec-

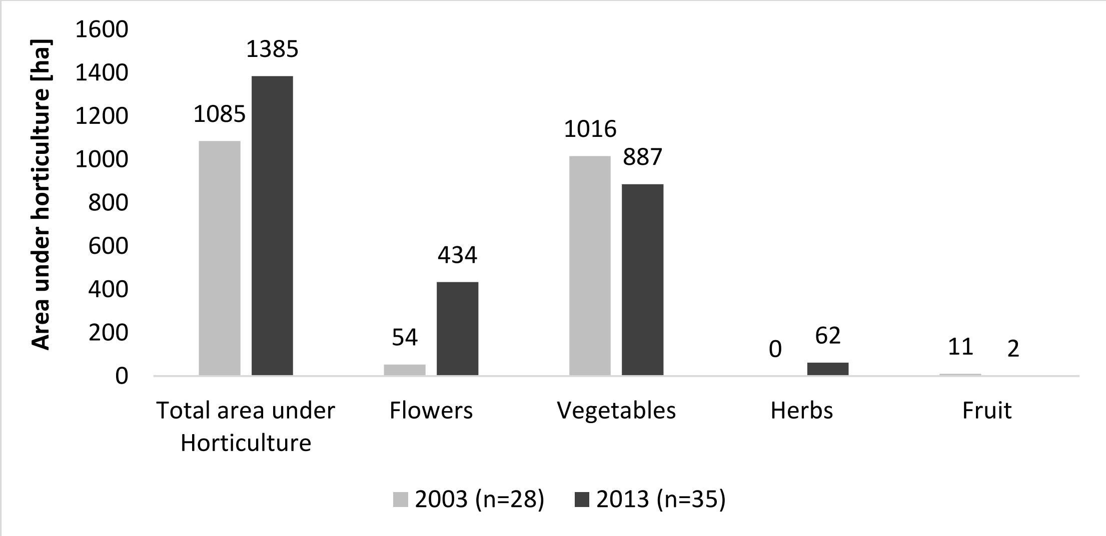

Figure 8.2: Area under horticulture per crop category of the commercial horticulture sector NW of Mt. Kenya in 2013 compared to 2003 (Source: Schuler 2004, 67; field survey 2013).

tares under floriculture is impressive. Additionally, the production of herbs for export is a quite new phenomenon, especially on this scale. Flowers and herbs together account for not only the increase of 300 ha cultivated area and the decrease of vegetable production, but also a further shift within existing cultivated horticultural land. In fact, C16 converted to flower farm E11, and C17 (now E15) gave up some of its land on which two different farms (E10 and E12) grow flowers today. Furthermore, if one compares the hectares under production by crop with the number of farms producing them, as shown in Figure 8.3 and Figure 8.4, new insights present themselves. In 2003, 15 farms focused solely on vegetable production while only three planted exclusively flowers. Other cultivated some kind of mix of vegetables, flowers, and fruits. Ten years later, there are still 10 vegetable farms but also 15 flower farms. Drawing the insights from Figure 8.2, Figure 8.3 and Figure 8.4 together, we can see that although the area under vegetable production decreased only moderately from 1016 ha to 887 ha, there are five fewer farms that focus only on vegetable crops. The dominant crop category on the 'mixed farms' is usually vegetables (in 2003 as well as 2013). Thus, in 2013 there were 16 farms cultivating vegetable horticultural crops in total compared to 24 (including mixes with fruit and flowers) in 2003. This makes for approximately 42 ha per farm under vegetable production in 2003, compared to an approximate 54 ha per farm under vegetable production ten years later in 2013. The increase in hectares per farm coincides with the impressions gained in the field that vegetable farms are rarer, but larger. While vegetable farms decreased in number, an upsurge in flower farms in the study area took place. Ten years ago, only three farms concentrated just on floriculture, while four mixed flowers and vegetables. Today, 15 pure flower farms operate in the study area and only one company plants a combination of flowers and vegetables. Of the 15 flower farms, all but one grow roses, and four additionally plant other flower crops (e.g. carnations, hypericum, and/or ringium). On average, each of these flower farms cultivates approximately 28 ha, corroborating the initial statement that floriculture requires less area to cultivate on while remaining profitable.

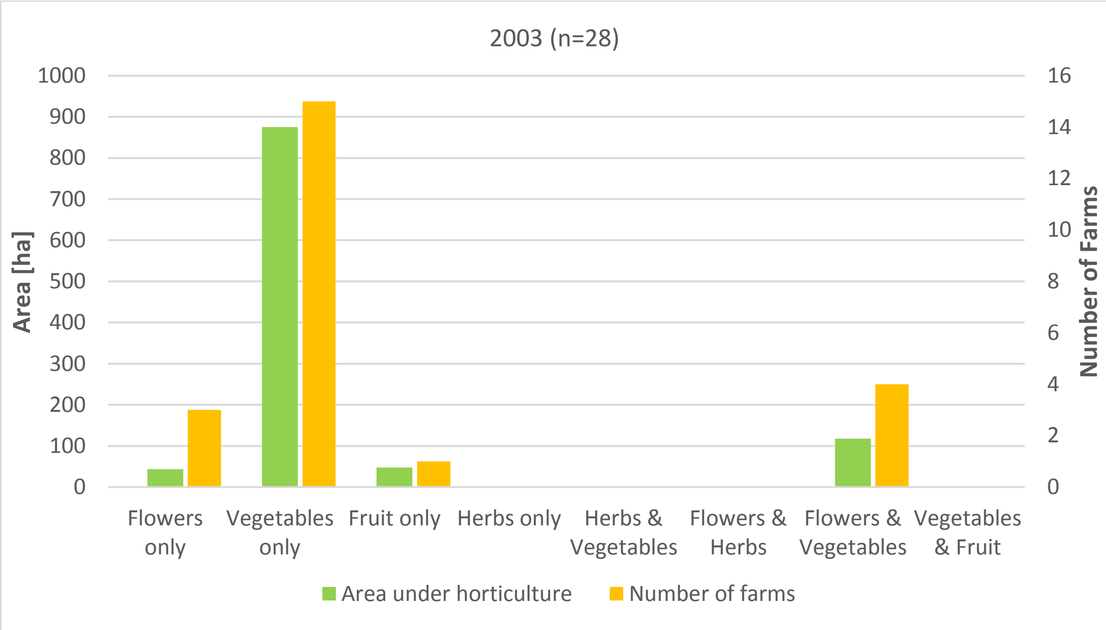

Figure 8.3: General Crop Orientation of commercial horticulture farms NW of Mt. Kenya in 2003 and area under horticulture of respective category (Source: Schuler 2004, 67).

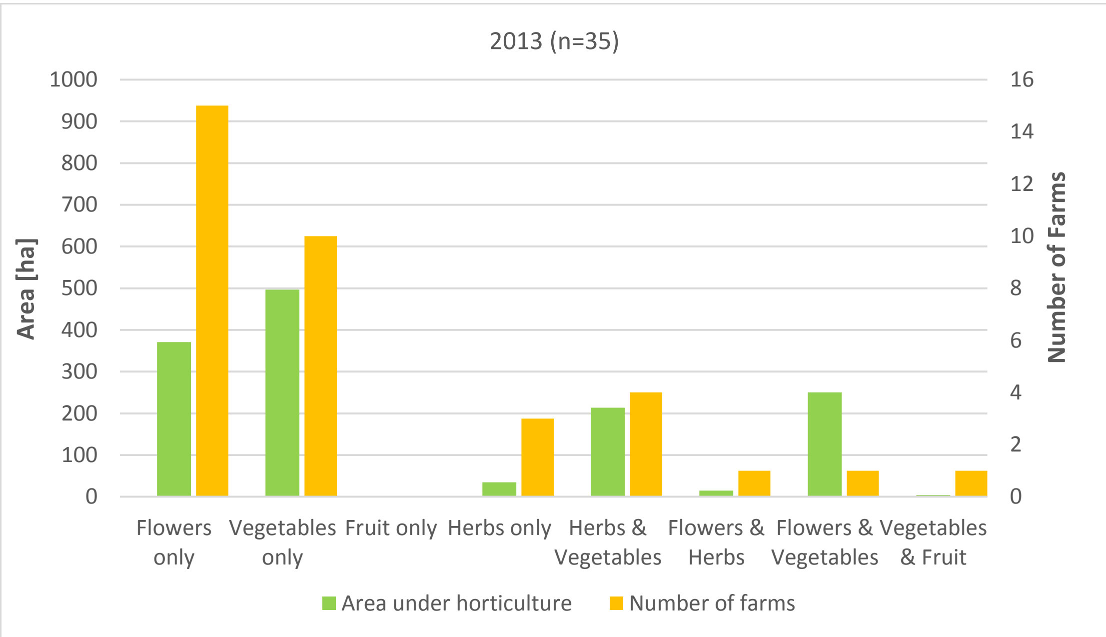

Figure 8.4: General Crop Orientation of commercial horticulture farms NW of Mt. Kenya in 2003 and area under horticulture of respective category (Source: field survey 2013).

This aspect is also clear from Figure 8.5, which shows the farms according to their sizes. Since 2003, the number of medium-scale and large-scale farms larger than 30 ha only changed slightly. However, farms ranging between 9 and 30 ha have drastically increased that is because most flower farms use between 15 and 30 ha. These smaller farm sizes are because flower farms are profitable on much less cultivated area, since flowers, and especially roses, are high-value crops. Flowers also require greenhouses, drip irrigation, and cold rooms, which necessitates more cost-intensive infrastructure than outdoor fields. Appendix I provides a list of the commercial horticultural companies in the study area in 2003 compared to 2013, in alphabetical order.

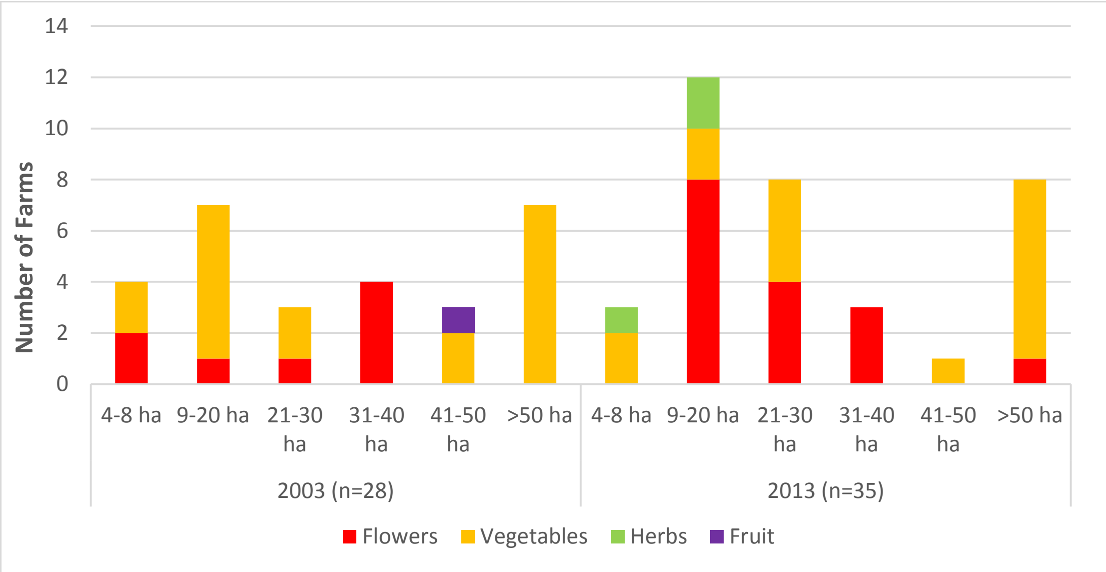

Figure 8.5: Area structure of medium- and large-scale farms NW of Mt. Kenya in 2013 and 2003. (Source: Schuler 2004:65; field survey 2013).

In 2003, 25 companies operated on 29 farms. One flower farm could not be visited at that time; Schuler subsequently disregarded it from his analysis, and set the sample size at 24 companies and 28 farms (Schuler 2004, 59). Today, 30 companies operate on 35 farms.[9] Interviews were conducted with 28 companies, as two refused. Some information on the those two companies, each with one single farm, was available via the internet (Vegpro Group 2013; Batian Kenyan Roses 2005), and for company E30 some structural parameters, e.g. farm size, could be gathered from the interview with E31, a former horticulturists and owner of the land on which E30 operates. Thus, the sample size is set at 30 companies and 35 farms.

Figure 8.6 shows the location of the various medium- and large-scale farms in the study area as of the inventory of 2013. The color variation by terrain indicates the various altitudinal ranges. The rivers, tributaries of the Ewaso Ng'iro, and the main towns are also indicated.

[9] Technically company E17 is operating on four different farms, but they are very close together, only separated by a road, and the same crops are planted on each farm, hence it was considered as one farm. In addition, the interviewee considered it as one farm, rather than four separate entities.

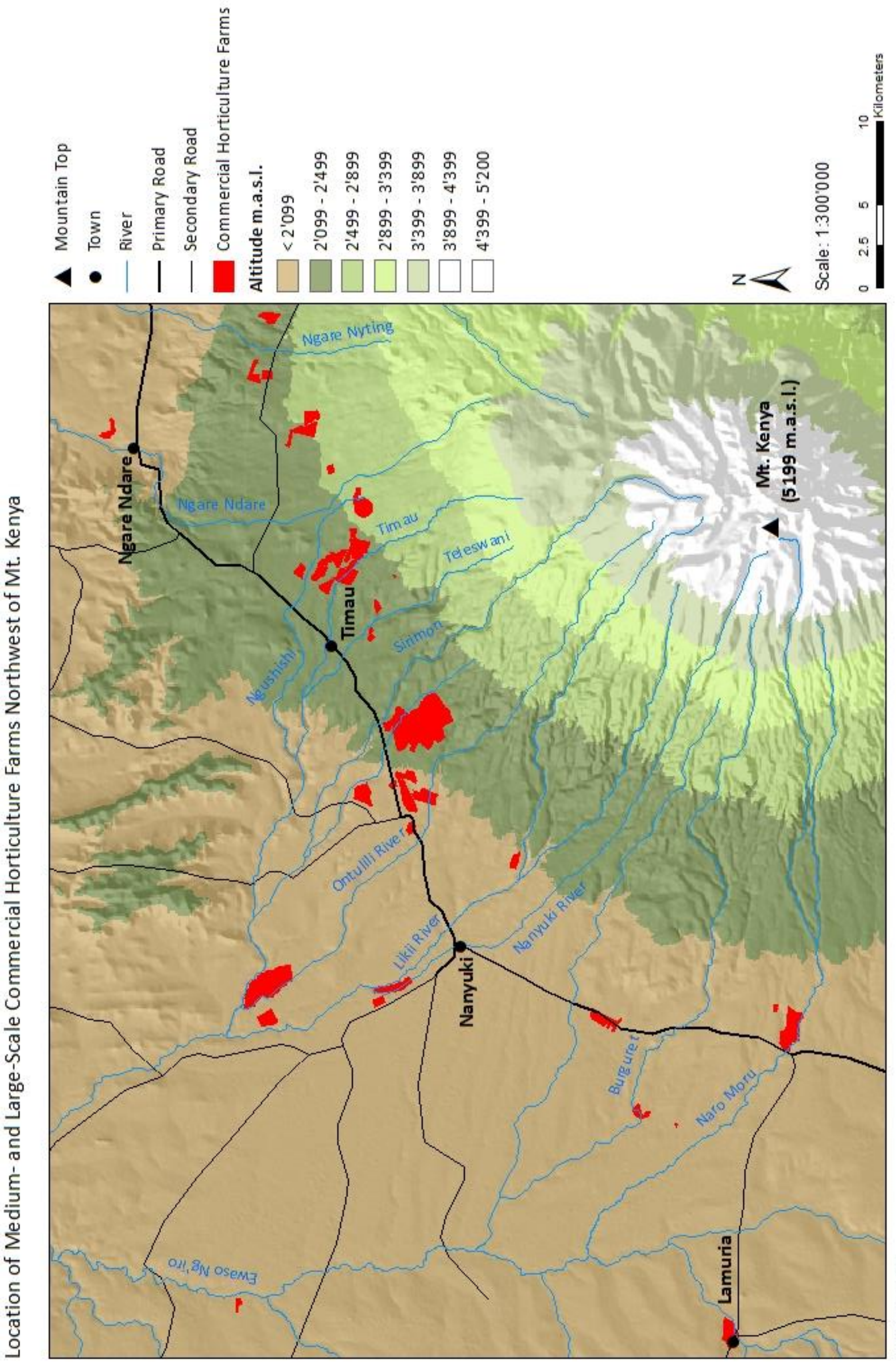

Figure 8.6: Location of commercial horticulture farms NW of Mt. Kenya (Source: field survey 2013; Google Earth; CDE)

8.2. Major Horticulture Crops

Contrary to 2003, when two major vegetable companies and their respective outgrowers dominated the sector in the study area, the commercial horticulture sector today aligns itself along the divide between flower and vegetable crops. Only one large-scale company, E15, bridges this gap successfully. Yet, what and how much does each side produce? The first part of that question is easily answered, but the quantity aspect is more difficult to evaluate, especially for vegetable farms. Vegetable farms plant the same plot at least two, if not three, times a year according to a planting program. This program can vary from one planting period to another, resulting in a great variety of products. During interviews, some respondents could not remember all the crops planted, the covered area, or the resulting harvest in tons. It is sometimes possible to fill this void through a follow-up phone call or e-mail, but more often than not, this was unsuccessful because interviewees felt the issue was concluded and did not want to reopen it.[10] This would not have been problematic if the missing data stemmed from a smaller farm. However, three of the large vegetable producers provided either partial or no production data. Hence, it is impossible to compare the production data from 2013 with the data collected in 2003 and make any significant statements. Therefore, production data in tons is not included in this thesis. The data on cultivated hectares for each crop is much sounder, with data missing only from the large-scale company E27 (142 ha) allowing for a rather accurate comparison.

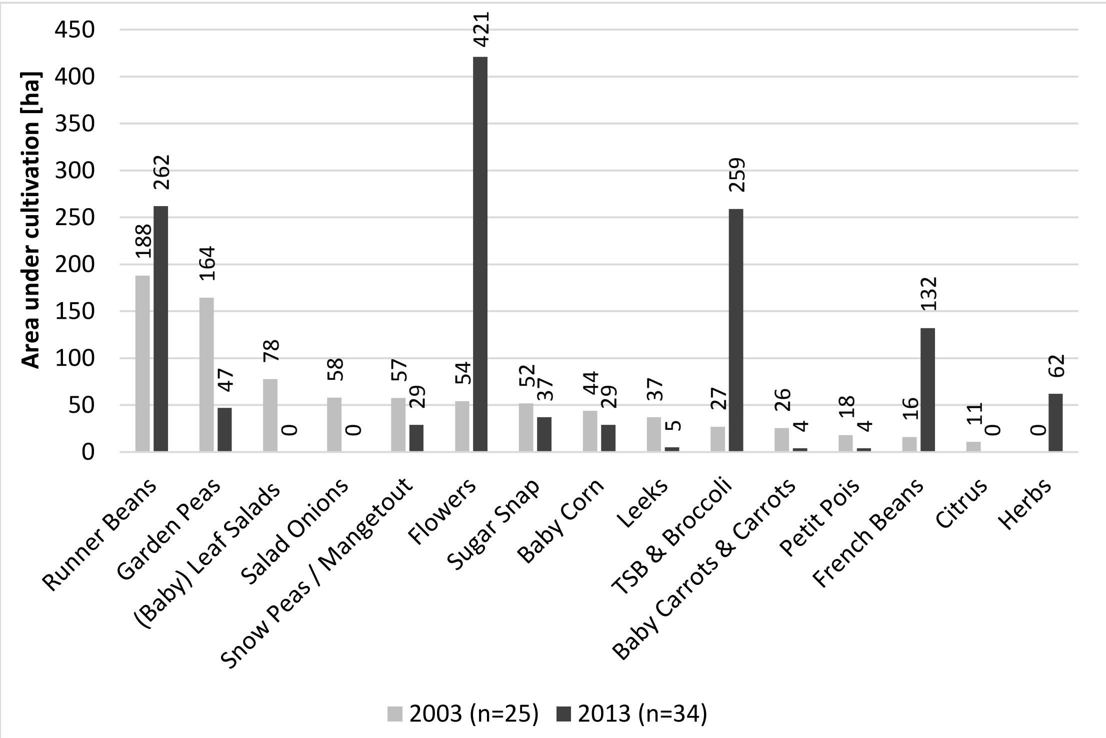

Figure 8.7: Mean annual area under cultivation of the major horticulture crops on medium- and large-scale hoticulture farms in 2003 and 2013. (Source: Schuler 2004, 69; field survey 2013).

[10] See chapter 5.2 on how qualitative research can be a source of irritation to the studied social system.

Figure 8.7 clearly shows the previously discussed increase in flower production,[11] as well as the emergence of herb production. Interestingly, within the vegetable-producing farms, a concentration and intensification on specific crops is observable. The produce variety in 2003 was greater, with runner beans and garden peas dominating. From the original twelve vegetable crops cultivated in the area, ten remained in production in 2013. Of these ten, three are practically negligible and cultivated on just four or five hectares. Today, runner beans still hold the lead, closely followed by tender-stem broccoli (TSB) and broccoli and French beans. Garden peas, previously the second most important crop, have seen a decrease by a factor of two-thirds in the product area under cultivation. Hence, although ten of twelve vegetable crops from 2003 were still cultivated in 2013, there is an evident concentration on three crops: runner beans, TSB, and French beans.

In 2003, the two major companies C16 and C17 and their medium- and large-scale outgrowers accounted for 69% of the total medium- and large-scale commercial horticulture sector's production. C16 converted to a flower farm, but C17 still produces vegetables (E15) and is the largest vegetable farm in the study area, together with E24 and E27, despite reducing its total farm size. The data on flower production today is much stronger than on vegetable production. Contrary to vegetable crops, flower production is measured in stems produced rather than tons.

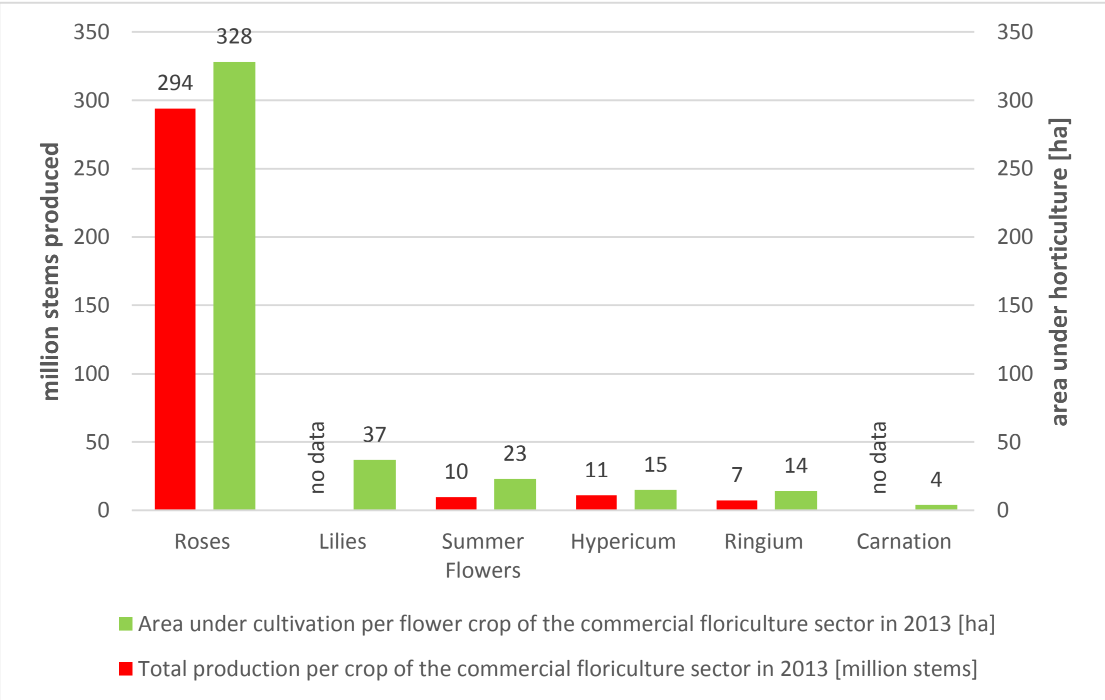

Figure 8.8: Major flower crops produced by the medium- and large-scale horticulture sector NW of Mt. Kenya in 2013 in terms of mean area under cultivation per year and million stems produced (source: field survey 2013).

[11] Flowers are an aggregate category of the different rose varieties and the other flower plants, e.g. hypericum, grown in the study area.

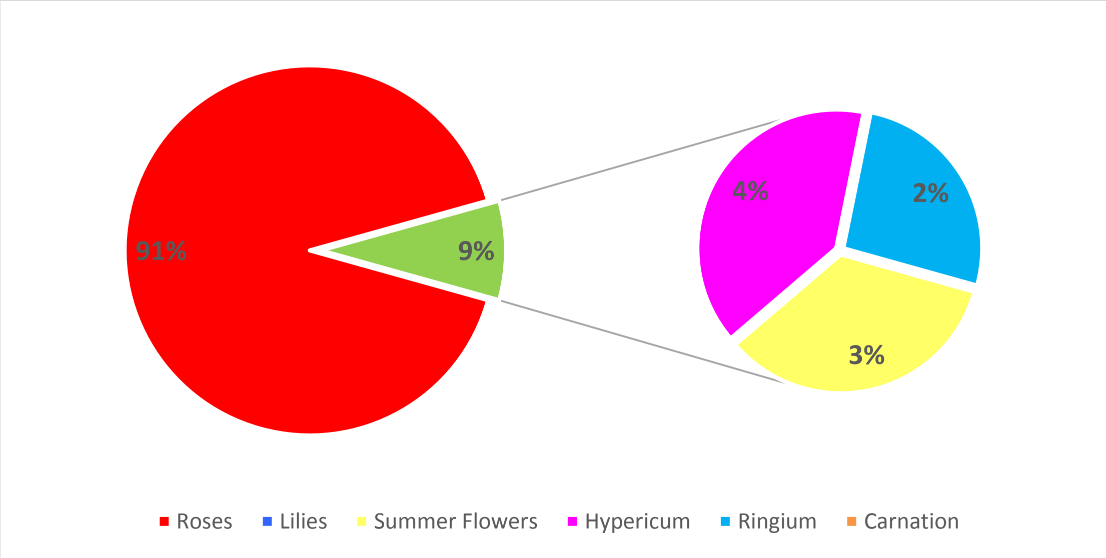

Figure 8.9: Share [%] of major flower crops cultivated NW of Mt. Kenya in 2013 in terms of million stems produced. Lilies and Carnations = no data. (Source: field survey 2013).

Sadly, in 2003 this data was not made available to Schuler, so there is no opportunity for comparison. Still, Figure 8.8 and Figure 8.9 show how roses dominate flower production in the study area compared to the other five flower crops. In 2013, roses were planted on 328 ha of 421 ha[12] and farms in the study area produced approximately 294 million stems. The other flower crops do not approach this number of hectares or volume in millions of stems produced. Roses maintain this dominant position because of their high return and amid increasing market demand. This is in line with the development of floriculture throughout the country. Three main rose varieties grow in Kenya: (1) Hybrid Teas, (2) Sweethearts, and (3) Sprays. The choice of the variety depends mostly on market availability, consumer preference, and availability of clean planting material. Hybrid Teas have a big flower head supported by a long stem, and need the high altitude and climate found in the study area northwest of Mount Kenya to thrive. Found under these varieties are: Astra, Cocktail, Darling, Tineke, Dallas, Jacaranda, Laminuette, Osiana, Passadena, First Red, Alsmeer Gold, Vivaldi, Madelon, Sonia, Prive, and Vega. Sweethearts have small to medium flower heads and short stems; they are also grown in the study area, but not as extensively as Hybrid Teas. They are, however, very popular in Naivasha. Included in this group are: Frisco, Kiss, Rossetta, Jaguar, Vicky Brown, Disco, Meilland, Florence, Gerdo, Jackfrost, Europa, Gabrielle, Ilisetta, Mercedes, Golden Times, Coco, Champagne, and Souvenir. In contrast to these varieties, which are exclusively grown in greenhouses, Sprays include outdoor and indoor crops. They have medium stem length and four or more flowers per stem. These varieties are newer and currently have limited market channel, but are already cultivated northwest of Mount Kenya. Examples include: White Dream, Rumba, Mimi Rose, Red Ace, Evelien, Diadem, Porceline, and Joy (HCDA 2013a). The most dominant rose

[12] The 421 ha is the mean area under floriculture per year. Lily production varies slightly throughout the year, accounting for the difference to the total area under floriculture, which is 434 ha.

variety in the study area is the Hybrid Tea. Growing conditions for these are ideal northwest of Mt. Kenya, as we will see in chapter 9. Hence, while each company in the study area grows different varieties and total numbers of varieties ranging from six to thirty, most farms in the study area cultivate Hybrid Teas.

8.3. Medium- and Large-Scale Outgrowers

All floriculture companies in the study area not only produce on their own farms, but also export the flower crops themselves. Companies that produce and export are called ‘exporters’ in this thesis. Some of the vegetable companies also are exporters. Others only produce and subsequently sell their crops to an outside intermediary, who exports. Companies concerned only with production and no other part of the business are called ‘outgrowers.’ It is not uncommon for medium- to large-scale commercial horticulture exporter companies producing vegetables to also contract outgrowers. These outgrowers are either small-scale horticulturists who operate on less than four hectares, or additional medium- to large-scale commercial farms. Exporters and outgrowers manage their relationship through a contract that outlines the deliverable crops, use of chemicals, mode and duration of payment, and indicates the price and the volume of produce. Most often, exporters order produce on a weekly basis, but indicate an estimated quantity in the contract. Generally, the outgrower receives seeds and technical support, but must purchase inputs such as fertilizers on their own. The contracted outgrower then grows the produce and can usually call upon technical support, an outgrower liaison officer, or an outgrower management team, depending on how large the scheme is. After harvest, produce goes into crates with no processing, and usually, the exporter will pick it up; however, sometimes the outgrower manages transport. Each party is responsible for their own side of the contract. If the outgrower cannot supply because of environmental circumstances (e.g. drought) or other impediments, they carry this responsibility. The exporter is responsible to the buyer because they cannot supply. Some of the exporters work exclusively with small-scale farmers, such as farms E15, E22, and E24. They supply the farmers with seed and technical inputs and have technical liaison officers (TLOs) who visit, help with sprays, and check on the crops. The small-scale farmers then harvest, and the exporters collect the produce in the evening to bring to a central hub for processing. The outgrower is, in this case, paid by weight.

Figure 8.10 shows the development of the outgrower scheme during the last decade. As stated previously, all flower farms are exporters, and are thus excluded from Figure 8.10. It is immediately apparent that in 2003, medium- to large-scale outgrower companies constituted a major

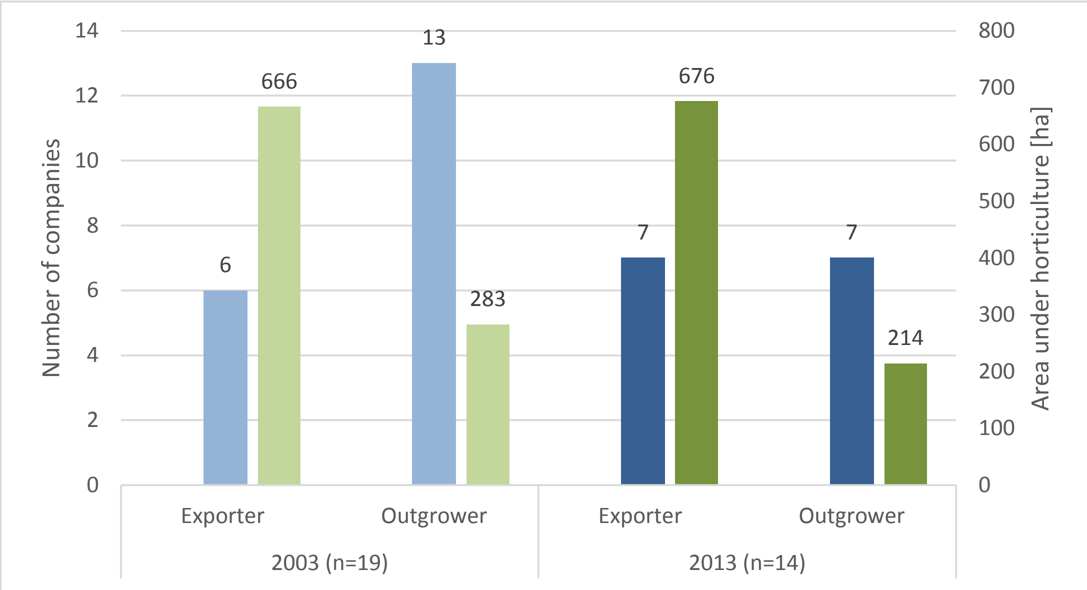

Figure 8.10: Exporters and outgrowers producing vegetable horticulture crops NW of Mt. Kenya in 2013 and 2003 (Source: Schuler 2004:60; field survey 2013)

part of the sector. There were thirteen outgrowers, and only six exporters to whom those outgrowers sold their produce. Interestingly, the exporters operated on twelve farms (C17 has six farms) on 666 ha, resulting in an average farm size of 55.5 ha. Contrastingly, the thirteen outgrower farms operated on 283 ha, resulting in an average farm size of approximately 22 ha. In summary, in 2003 there were twice as many outgrowers as exporters, but exporters generally had the larger farms. By 2013, this situation changed drastically: there are only seven medium- to large-scale outgrowers left in the study area. They operate on 214 ha, increasing the average farm size to approximately 35.5 ha. At the same time, the number of vegetable exporters increased from six to seven. The exporters' average farm size increased to approximately 61.5 ha (see Appendix I for a detailed list of all exporters and outgrowers).[13] In the past decade, the number of medium- and large-scale vegetable outgrowers reduced from thirteen to seven farms. However, their average farm size increased from 22 hectares to 35.5 hectares. Thus, the average size of vegetable farms increased for all companies, be they exporter or outgrower. A reason behind this size increase may be the fact that the prime years for vegetable exports have passed. When Schuler visited the study area in 2003, vegetables exports were paramount; however, they began a slight decrease shortly afterward in 2004. The market for beans and peas, especially, further plunged with the crisis in 2007, when the exchange rate with the Pound and the Euro made the production of certain vegetables no longer viable (interview E7). Therefore, it is probable that smaller outgrowers were simply not profitable and competitive enough, as underlined by the following citation:

[13] E15, E19, E22, and E27 each operate on two separate farms.

> "Being aggressive [is necessary]. The export market is not a bed of roses. It has got its own challenges, its own players and its either you are able to measure to the task, or you're out." (Interview E27)

Additionally, outgrowers depend strongly on their relationship with the exporters. Interviews with former horticulturists (E31 and E32) suggest that rotation crops were not always provided. Consequently, the soil suffered from monocultures; pests and insects infested the crops more strongly, and crop yields started to fall drastically. The sector also struggled in relationships with European supermarkets. Margins in vegetable production are typically very tight, and controlled by supermarkets. Furthermore, health requirements, hygiene, and other restrictions imposed by supermarkets demand large financial investments. Therefore, there is a simultaneous increase in production costs to comply with supermarkets standards alongside a decrease in profit margins. For outgrowers, this meant that if they could not operate according to these standards, their produce was rejected. Both constraints apply generally to the vegetable part of commercial horticulture in the study area: the golden age of vegetables has passed, and hence, the need for medium- and large-scale outgrowers diminishes, as illustrated by the following quote from a former outgrower:

> "[…] there has been a big shift towards floriculture. Horticulture [vegetable crops] is dying down because of supermarket treatment. The supermarket treated horticultural farms and exporters really bad: there were more and more restrictions and they were pushing the price more and more down. When airfreight went crazy [due to the volcanic eruption of Eyjafjallajökull) they never increased prices, so they strangled it [the producers] down. […] [E11] was the biggest horticultural farm in Kenya [roughly 200 ha] and it closed down, now they've got 20 ha of roses. Horticulture had its golden age but no longer." (Interview E31)

The only clear way to remain profitable is to operate on a large scale and add value (interview E12). To make matters more difficult for outgrowers, in an ever-sensitive market, exporters usually dealt first with their own produce, only selling the outgrowers' share if their own produce sold successfully.

To summarize, commercial horticultural companies cultivating vegetables are operating on increasingly larger farms in order to stay competitive. They most often operate on their own farms, and work with smaller outgrowers. This also allows for tighter control of production in order to comply with supermarket regulations.

8.4. Market Orientation

Ten years ago, the UK represented the key export market, with 12 of 24 companies delivering at least 90% of their export produce to it, and three more companies delivering between 30%

and 90% to the UK (see Figure 8.11).[14] The Netherlands constituted another large market, with two companies delivering more than 90% of their produce there, and another four companies delivering between 30% and 90%. Hence, 15 companies delivered directly to the UK and another six delivered directly to the Netherlands, for a total of 21 of 24 companies supplying British and Dutch markets to some extent. Minor markets in 2003 were mainly Germany and France, and one Middle Eastern country.[15] Figure 8.12 gives a visual overview of the sector's major and minor export destinations.

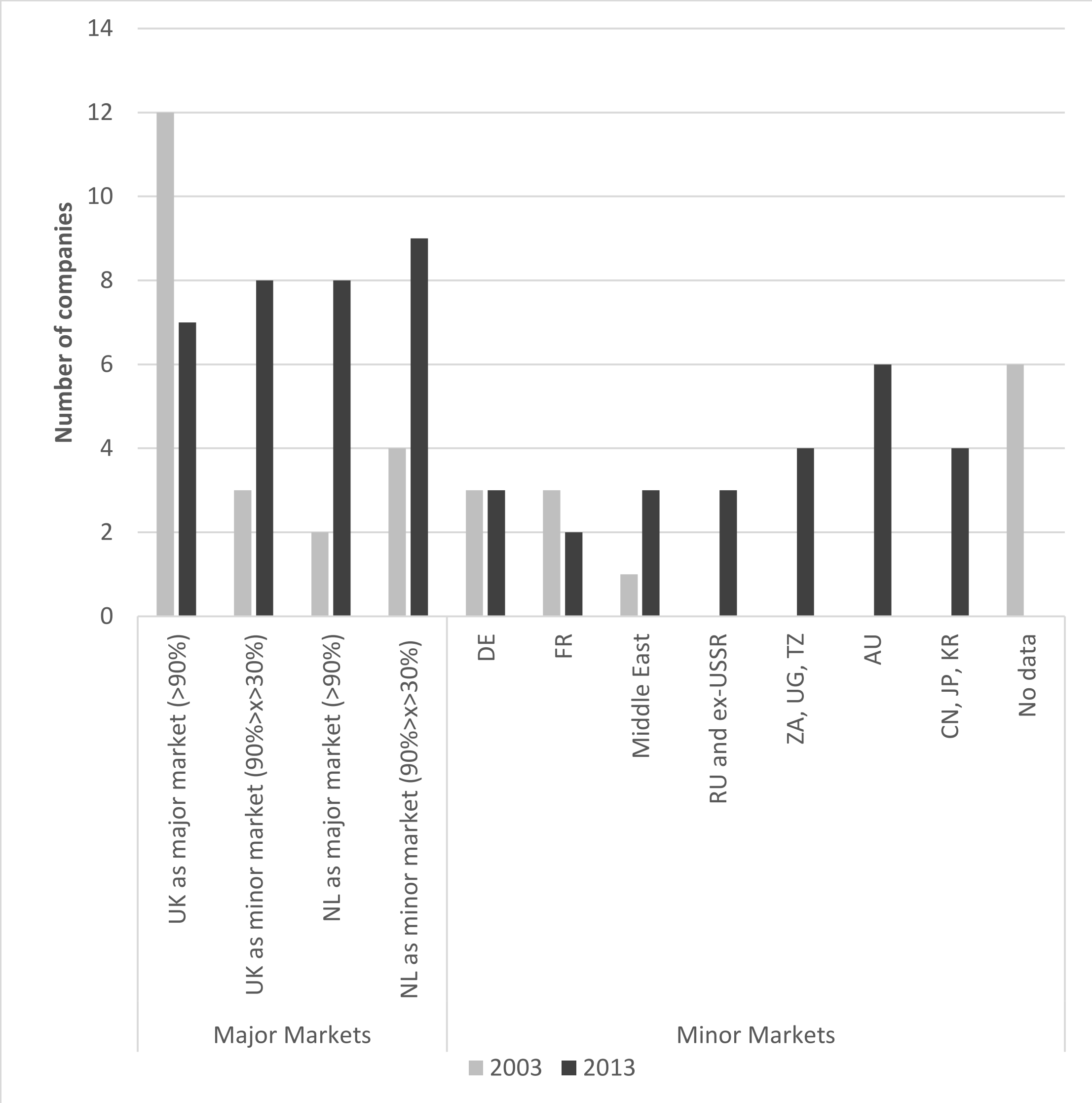

Figure 8.11: Export destinations of the commercial horticulture sector NW of Mt. Kenya and respective number of companies (source: Schuler 2004, 71; field survey 2013).

[14] Figure 8.11 shows the market orientation of the different companies. Exporters as well as outgrowers are included here, even though outgrowers do not export themselves. However, most of the outgrowers knew the destination of their produce despite it being exported through intermediaries, hence their inclusion in the figure

[15] One company could not be interviewed in 2003; Schuler subsequently disregarded it from his analysis, setting the sample size at 23 instead of 24. This company is a flower farm, and it is very probable that it supplied the flower auction in the Netherlands at that time.

Today, vegetables still flow primarily to the UK and the Netherlands, either to wholesalers who then supply various supermarkets or directly to major supermarkets such as Marks & Spencer, Tesco, and Sainsbury in the UK, and Albertine in the Netherlands. However, the emergence of floricultural companies in recent years shifted the almost unilateral market orientation toward the UK and increased the importance of the Netherlands. The latter change is because the Dutch flower auction FloraHolland brings in supply from most Kenyan flower farms.[16] Of the eight companies indicating the Netherlands as a major market, seven directly supply the auction, and of the nine further companies citing the Netherlands as a minor market, three directly supply the auction. From the auction, the flowers are then distributed all over the world, but mostly in Europe and Russia. However, not all floricultural companies favor the auction. Most supply it to start their business, but some have since reverted totally or partially to direct sells, opening markets in Russia, Australia, Japan, China, South Korea and some Middle Eastern countries such as the United Arab Emirates. The advantage of direct selling is a stronger focus on quality over quantity, which the auction seems to desire. Hence, if a company is rather small, it is difficult for it to make an impact at the auction (interview E8). Therefore, direct sells are an interesting alternative, and markets are opening up mostly outside of auction-dominated Europe. Buyers are mostly wholesalers such as MOSTROV and Seven Flowers in Russia, or Mr. Fresh in Australia. In 2013, a majority of flower farms still supplied the auction in various quantities of their total production. However, it seems to be a future trend for floriculture companies in the study area to develop direct selling relationships with various international customers.

Info-Box 3: FloraHolland

FloraHolland is a co-operative organization of and for horticultural products. They are a sales organization with a strong international trading platform. The Netherlands might have been the birthplace of the floriculture sector in the 19th century. However, in recent years, horticultural production outside of Europe has become increasingly important. Due to the digitization and virtualization of the horticultural world, international trade in plants and flowers will continue to grow. FloraHolland has a number of marketplaces with 38 auction clock sales systems. Annual turnover is 4.5 billion euros, and they sell 12.4 billion plants and flowers a year to 2,400 customers. The main imports come from Kenya, Ethiopia, Israel, and Belgium. The main exports go to Germany, Britain, France, Italy, and Russia. The expansion of international service networks in order to bring together supply and demand of horticulture products is one of the organization's main goals (FloraHolland 2014).

[16] See Info-Box: FloraHolland and the auctions homepage for more detailed information: www.floraholland.com

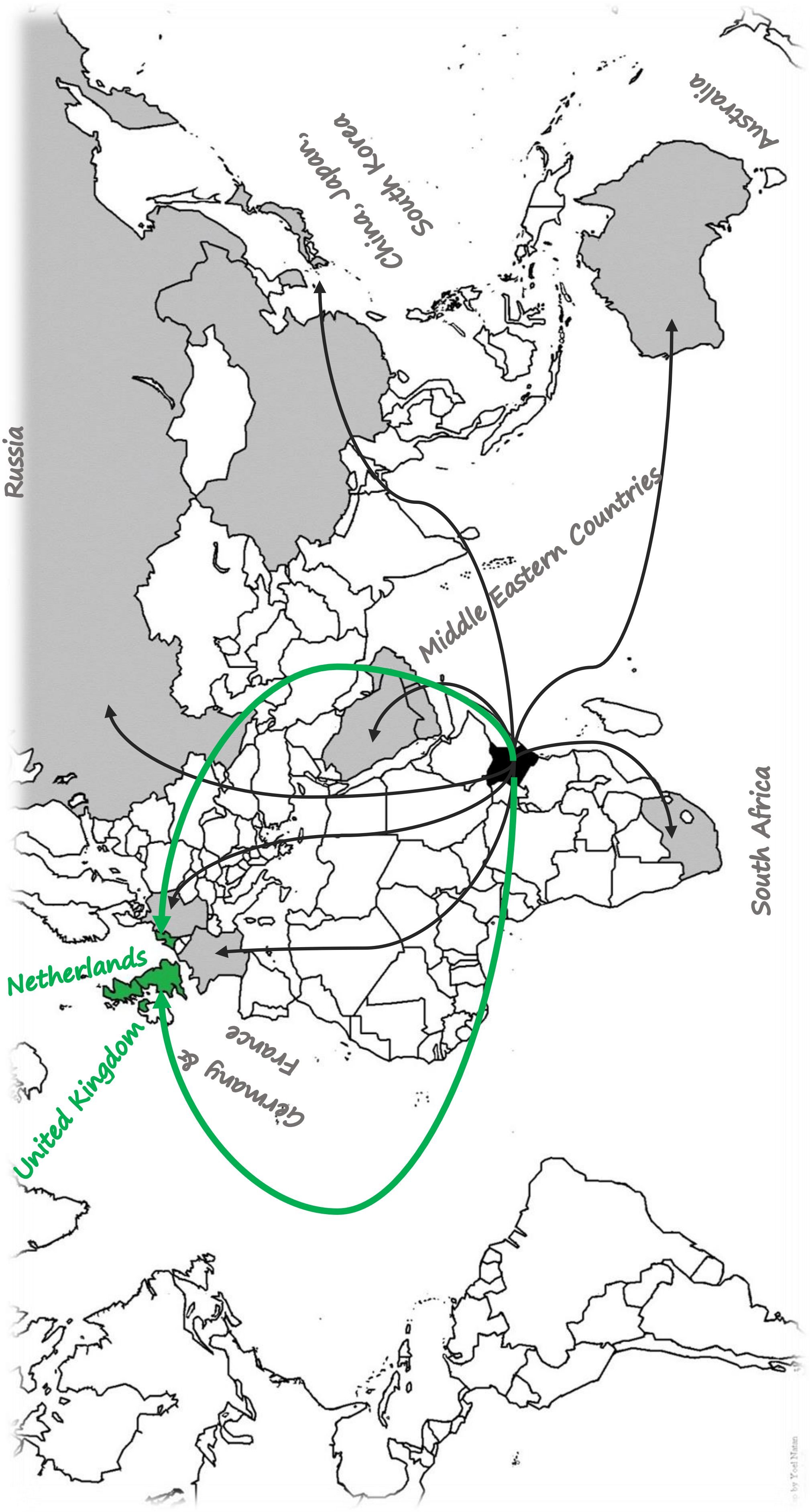

Figure 8.12: Major and minor export destinations of commercial horticuture produce NW of Mt. Kneya (Source: own illustration; http://isghd.com/images/wall6/world-map-outline-labeled-widescreen-2.gif [Accessed September 12, 2014]

8.4.1. Commodity Chain

Practically none of the produce cultivated and harvested in the study area sells locally and is instead exported, as seen in section 8.4, with most trade heading toward Europe alongside smaller markets in Russia, Australia, and some other countries. This demands impressive logistics; while this aspect is not a focus of the present study, below are two examples of the commodity chain for a vegetable crop and a flower crop in order to clarify this process.

The example of tender-stem broccoli helps to illustrate the commodity chain of vegetables. Usually, a seedling grows in a nursery for approximately five weeks. The nursery may belong to the company or be an external entity that specializes in this task. The seedling then comes back to the farm where it is planted and, depending on the crop, harvested after 8 to 16 weeks. Just after harvest, the crop is graded and brought into the packhouse, if there is one on farm. From this moment, it takes roughly one day to process the harvested produce. On the second day, the harvest goes to the airport in trucks. If the packhouse is located in Nairobi rather than on the farm, produce is graded on the farm and then trucked every evening to Nairobi for processing. Most companies have a plane leaving Nairobi every night with a load between 60 to 100 tons. The freight arrives in the UK on the second or third day and will arrive at the various supermarkets by the fourth day, where it has a shelf life of approximately eight to nine days. In summary, the first day comprises harvesting and processing, the second day is for transportation, and on the third day the produce arrives at its destination; the final step in the process can sometimes take an extra day, depending on customs clearance rates (interviews E15 and E27).

Most flowers produced in the study area are roses, and thus, this crop offers another good example. First, the desired variety must be chosen, followed by a supplier for that variety. The supplier cuts the stems and gives them to a propagator who then grafts them onto a rootstock. One might get four eyes from one stem, which can then graft onto another rootstock. This process is most often external to the company. The next step is the planting new rootstocks in greenhouses, which is a delicate stage: the crop needs a lot of water, and diseases have to be kept at bay. After four months, the first roses bloom. Those are usually of lower quality, but can still be sold. Maximum production arrives within two to three years. Rose crops require significant care and control administered through pesticides and fertilizers. Roses are a delicate live product; hence, the commodity chain is a cold process. The harvest takes place in the greenhouses where the roses are grown, which is comparatively hot at 28°C. The cutting stage is very important: if one cuts them too early, they never open, whereas if one cuts them too late, they open up too early and the person buying the rose will only have two to three days to enjoy them. Each rose variety has a specific cut stage. After harvest, the crops are transported into a cold room as quickly as possible, usually within twenty minutes, where they cool down to about 4°C for at least six hours, and sometimes as long as a full night. Following this process, the harvested roses are defoliated by hand, graded, packed with corrugated cardboard, leveled, sleeved, and boxed, after which they are placed back into a another cold room for forced cooling to about 2.5°C. Early the next morning, a cooled truck comes to pick up the produce and deliver it to the airport in approximately four hours. At the airport, the packed roses are loaded into another cold room (5-6°C), where they wait for processing onto specific flights. Depending on the buyer, different shipping agents handle the air transport. Finally, the produce is loaded onto the plane and shipped to the destination. Most of it goes to the auction in the Netherlands, as discussed in chapter 8.4. There, a worker unpacks the produce and cuts the roses again, because a fresh cut give the roses new life to absorb more water. Then they are sorted again and presented at the auction. Outside of the Netherlands, another important, emerging market is Russia, especially for Hybrid Teas. In this case, once the produce arrives at the airport, it is transported to its destination through Russia via truck. During the winter, the trucks have to be heated to prevent the delicate flowers from freezing. Most buyers therefore receive their roses after four to six days. In case of the auction, some roses can be a week old before they are sold to the end customer. The vase life is typically at least 12 days after it reaches the home of the buyer. Most roses produced in the study area are not scented, as they have harder petals and therefore live longer. Scented roses breathe out oil, which softens their petals and reduces vase life. However, some companies still produce them, such as E7 and E8 (interviews E5, E7, E8, E11).

These two examples show how complex the life of a horticulture crop is in terms of logistics and markets. They also present interesting research questions: what are the energy requirements of these crops? Can the ecological footprint be quantified and assessed? Who are the different actors involved in every step of this commodity chain? Where are they located?[17]

8.5. Summary: Inventory and Structure

The commercial horticulture sector northwest of Mount Kenya consists of 30 companies operating on 35 farms. Of these, 28 companies were interviewed and 27 farms were visited. In 2003, during the first study conducted on this topic, there were 24 companies operating on 29 farms. This increase in the number of companies and number of farms has been accompanied by an increase in terms of area under cultivation from 1085 hectares to 1385 hectares. This is relatively weak growth compared to the period from 1991 to 2002. As a result, the average farm size remained practically the same, at 39 hectares. Thus, a general reduction in the average farm

[17] Some of the companies collaborate with external marketing agencies, e.g. in Dubai, which handle the sales and speak the customers' language, e.g. Russian.

size of the commercial horticulture sector northwest of Mount Kenya is observable. Furthermore, there are two structural characteristics of the sector in the study area.

The first one expresses itself along the divide between flower farms and vegetable farms. Currently, there are fifteen flower farms and ten vegetable farms in the study area. There are also farms producing mixed goods, such as the combination of vegetable and herb crops. Thus, the study area has undergone an evident shift from a vegetable-dominated sector toward increasingly more flower farms. In contrast, a decade ago, there were only three flower farms and fifteen vegetable farms, as well as five farms producing mixes. Moreover, flower crops yield higher returns than vegetable crops, and thus, floriculture companies are generally either equally or more profitable than vegetable farms while comprising fewer hectares. Hence, the previously observed reduction in average farm size links directly to this shift from vegetable crops to flower crops. The emergence of herb production is a new development, and is expected to increase in the coming years.

The second structural characteristic of the sector aligns itself along the divide between outgrowers and exporters. An exporter is a producer that exports its own produce, while an outgrower concerns himself only with crop production and sells his produce to an exporter. All flower farms in the study area are exporters, and outgrowers are only contracted for vegetable production. The number of vegetable outgrowers in the study area decreased significantly from 13 to 7 between 2003 and 2013. Although we have seen that average farm size is now smaller throughout the sector, vegetable farms, be they exporters or outgrowers, evolved in the opposite direction. Their farm sizes increased by approximately 6 hectares for exporters and 13.5 hectares for outgrowers. There are fewer outgrowers today for the same reason as that there are less vegetable farms today: the prime years of vegetable exports are in the past. There are three primary reasons for this: first, market demand has decreased since 2003 and plunged further with the crisis in 2007 when the exchange rate between the Pound and the Euro made the production of certain vegetables no longer viable. Secondly, many farms did not practice crop rotation. Consequently, soils suffered from monocultures as pests, insects, and diseases infested crops more strongly, pushing down crop yields. Finally, the relationship to European supermarkets has grown increasingly strained. Margins in vegetables have become tighter under the control of supermarkets, while requirements regarding hygiene, health, Maximum Residue Levels (MLRs), and other restrictions have increased. Hence, compliance with requirements demands large financial investments, which is not always possible for the producer, especially when the producer is a smaller outgrower. However, if one does not comply with these standards, the crops are rejected. Thus, the reduced demand of vegetables in combination with a need to strongly control production and comply with regulations has reduced the need for medium- and large-scale outgrowers. The only way to remain profitable appears to be going large and adding value (interview E12).

The major crop grown in the study area is roses, which occupy 328 hectares, or almost one quarter of the study area's horticultural land. Other flower crops cultivated northwest of Mount Kenya include lilies (37 ha), summer flowers (23 ha), hypericum (15 ha), ringium (14 ha), and carnations (4 ha). Currently, there are also approximately 62 ha of herbs grown in the study area. The main vegetable crops produced are runner beans (262 ha) and tender-stem broccoli (259 ha), and French beans (132 ha). In 2003, vegetable production dominated the sector with 94% of production by land dedicated to it. Only 5% went toward flower production, with the remaining 1% comprising fruit production.

The commercial horticulture sector northwest of Mount Kenya is heavily export-oriented. Flowers are mostly exported to the Netherlands, where they are sold to the flower auction FloraHolland. Some companies in the study area sell their product directly to the end customer, opening markets mainly in Russia and Australia and representing a trend that seems likely to continue in the future. The floriculture business experiences almost no seasonality in demand and thus production; Valentine's Day constitutes an exception, which however is minimal in the overall picture.

In contrast, vegetables' main destinations are various supermarkets mostly in the UK, such as Marks & Spencer and Sainsbury's, alongside some in the Netherlands, such as Albertine. Demand for vegetables is highest during the European fall and winter and lowest during the European spring and summer, when supermarkets can sell domestic produce. This seasonality of demand causes a corresponding seasonality in production, which was strongly evident in 2003, when production dropped 50% during the European summer only to increase again in the European fall and winter, which coincides with dry season in the study area. Thus, it makes irrigated, export-oriented production particularly difficult. In terms of area under cultivation, this seasonality has decreased since 2003. Today there is roughly a 30% drop in production during the European summer compared to the dry season. Therefore, not only did the number of hectares under cultivation increase, but seemingly, also the intensity of production throughout the year.

Now, to understand better these findings concerning the current state of the commercial horticulture sector in the study area compared to 2003, the development of the sector is reconstructed in the following chapter. Special emphasis is placed on enabling conditions and limiting factors.

9. Development of the Commercial Horticulture Sector

Commercial horticulture northwest of Mount Kenya started in 1991 due to a partnership between a local farmer and Homegrown (K) Ltd. This collaboration sprung forth from a combination of the advantageous growing conditions in the study area and increased market demand. The local altitude, climate, availability of large and fertile land, and availability of water resources offered an ideal environment, while growing European demand for Kenyan horticultural products provided a strong business opportunity. This first step would prove to be critical for the development of the industry in the region. Homegrown (K) Ltd., was one of the major Kenyan horticulture companies, and its confidence in the growing conditions soon attracted other companies to the market. Other important preconditions for the establishment and growth of the sector included preferential trade agreements (Lomé Conventions and Cotonou Agreement), improved airfreight capacity between Europe and Nairobi, and the decline of cereal prices because of the Uruguay Round of Agreements on Agriculture (URAA). Governmental noninterference and state export incentives coupled with advantageous socioeconomic conditions for export-oriented horticulture production in both availability and cost of labor to enhance the opportunity. Furthermore, the high quality of public infrastructure enabled the sector to develop and expand. The growth in the area from the study's inception until 2003 was in line with national growth in the Kenyan horticultural export industry during the same period: from 1991 to 1994, the study area showed little growth, whereas the years between 1995 and 1997 represented a period of take-off. Between 1991 and 2002, annual growth averaged nine percent, or roughly 85.8 ha per year (Schuler 2004, 152–153). For a detailed description of the initial years of commercial horticulture in the study area please consult Schuler (2004, 75–77).

9.1. Development of the Commercial Horticulture Sector since 2003

Prior to initiating horticultural production, most of the farms in the study area already existed in some form. Figure 9.2 illustrates previous land use and the number of farms engaged in each type of land use. In 2003, the most common practice on farms prior to the introduction of horticulture was cereal cultivation. It remained the dominant land use indicated by horticulturists in 2013, alongside a similar number of farms practicing mixed farming (cereal and livestock), accounting approximately for 68% of the studied farms .This links to the area's history as colonial ranching land (see chapter 1.1), as both of these activities are rain-fed. Further previous land uses such as potato farming or leaving land to lay idle are either rain-fed or do not require any water. Adding these activities to livestock and cereal production, we find that 82% of the studied land currently under irrigated commercial horticulture practice (representing 1133 ha of 1385 ha), previously required no irrigation.

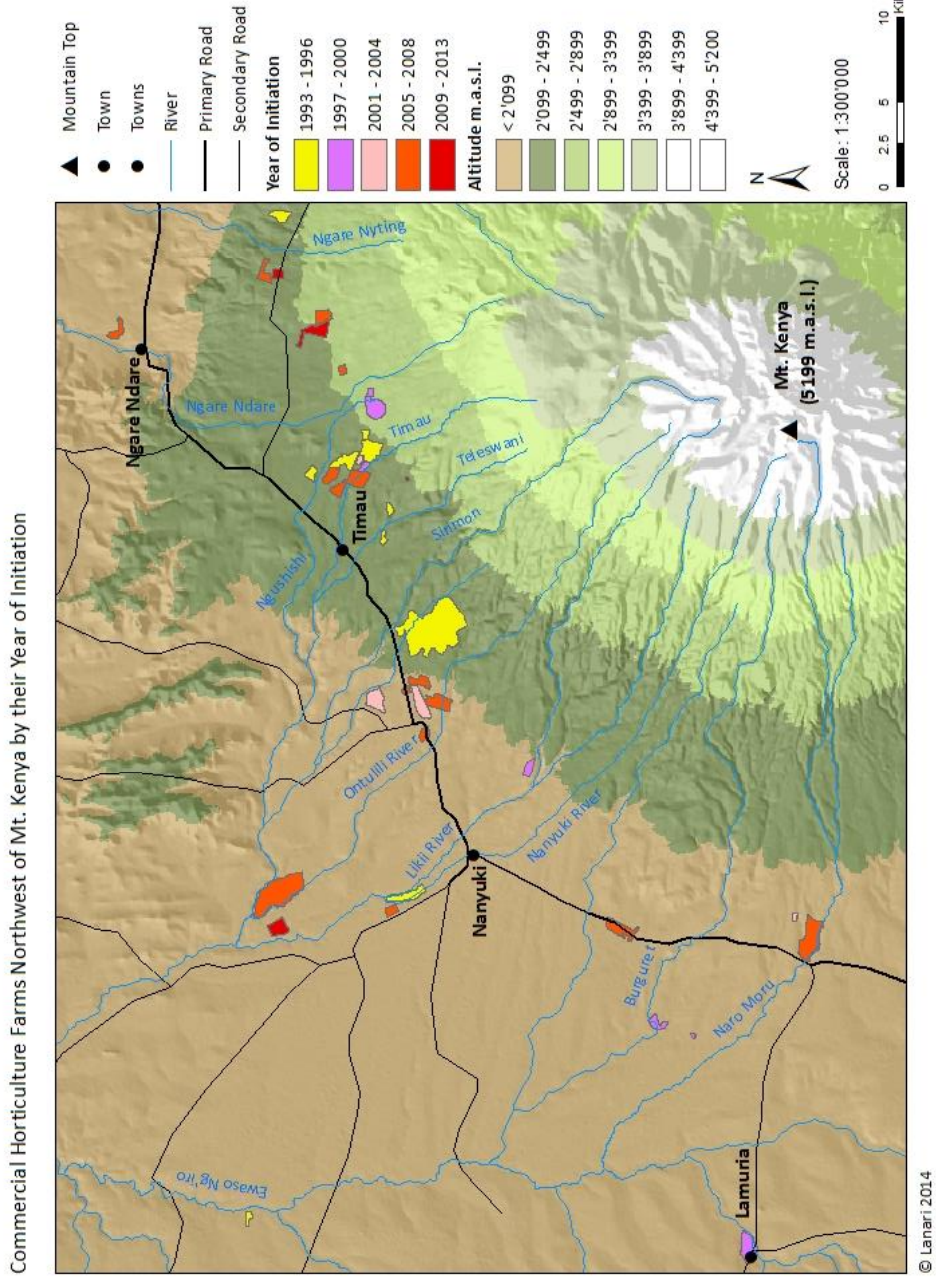

Figure 9.1: Commercial horticulture farms NW of Mt. Kenya grouped by their year of initiation (Soruce: field survey 2013, Google Earth, CDE)

Hence, the transition of these agricultural lands to irrigated commercial horticulture has had a heavy impact on water resources in the study area. Interestingly, in 2013 four farms listed 'horticulture' as their previous land use. One of these companies transplanted its herb business to a new farm E23, coworkers took up production on the existing farm, and herb production continued similarly as with the old company. However, the other three farms converted vegetable horticulture land into flower farms. E10 and E12 both bought land from E15 (formerly C17) when the company significantly reduced its total farm size, operating on two farms instead of its total of six in 2003. E17, the largest flower farm in the study area, bought most of its land from E11 (formerly C16 and previously the largest vegetable producer together with C17) when E11 shut down its own vegetable production in favor of floriculture. If the shift towards flowers persists, it is likely that such transactions will continue in the future.

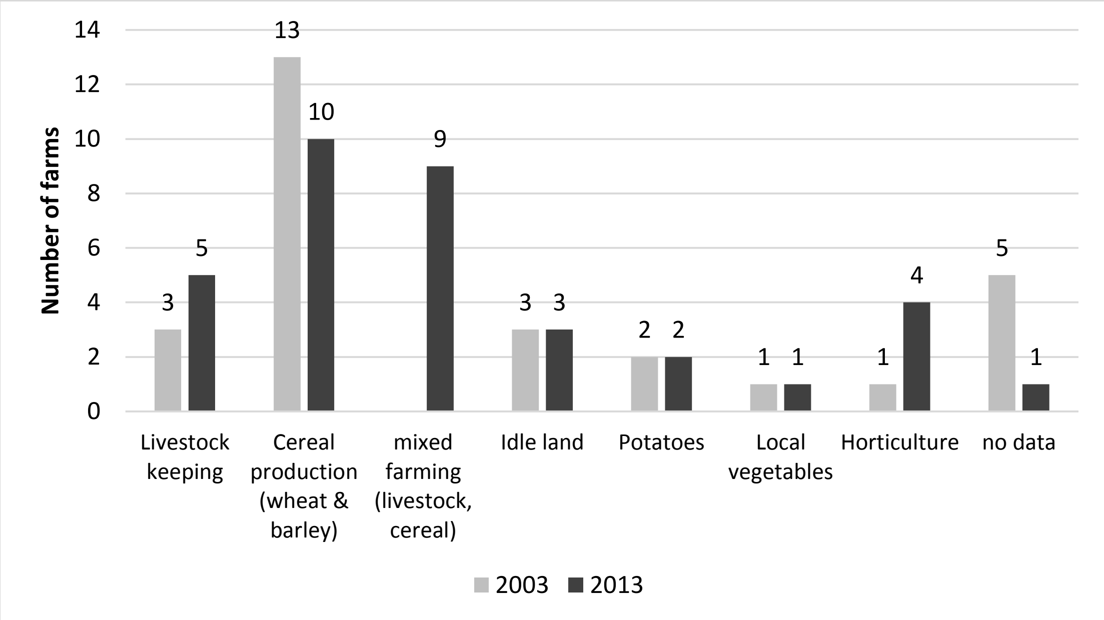

Figure 9.2: Land use on medium- and large-scale horticulture farms prior to horticulture indicated in 2013 and to 2003. (Source: Schuler 2004, 81; field survey 2013)

Returning to the general development of commercial horticulture in the study area, it is evident that the sector has flourished since the first farm opened in 1991. Figure 9.1 maps out the commercial horticulture farms according to their dates of initiation. Figure 9.3 shows the same data in a column diagram. In ten cases, different dates of initial production were indicated by the same farms during the field survey in 2003 and the field survey in 2013. This is likely due to either management turnover, with new supervisors unaware of the exact initiation dates, or simple memory failure. Additionally, eight farms closed completely during the past decade, taking up different activities than commercial horticulture.

These farms are no longer visible in the 2013 data. Another eight farms closed, sold to new ownership, and reopened during the study period.[18] These farms appear in both data sets with differing dates of initiation, as they are considered as different companies. The sector's take-off period between 1995 and 1997 is evident in Schuler's dataset (light gray), but less clear in the data from 2013 (dark gray). 1995, in particular, illustrates an immense gap. This discrepancy can be explained by a difference in the perception of the individuals interviewed. Five of the seven farms established in 1995, as collected by Schuler, were discrete parts of C17.2, with each newly initiated part identified as an establishment. C17.2 is still operating, now codified as E15.1, but the manager interviewed in 2013 indicated a single initiation point encompassing all five farms in1998. These differences in human perception of an event and how it developed are subjective, and there is no single and verifiable truth. Thus, and in order to include the farms that have closed down since 2002, Schuler's data set is considered for the period from 1990 to 2002, while the 2013 data set is considered from 2003 on.

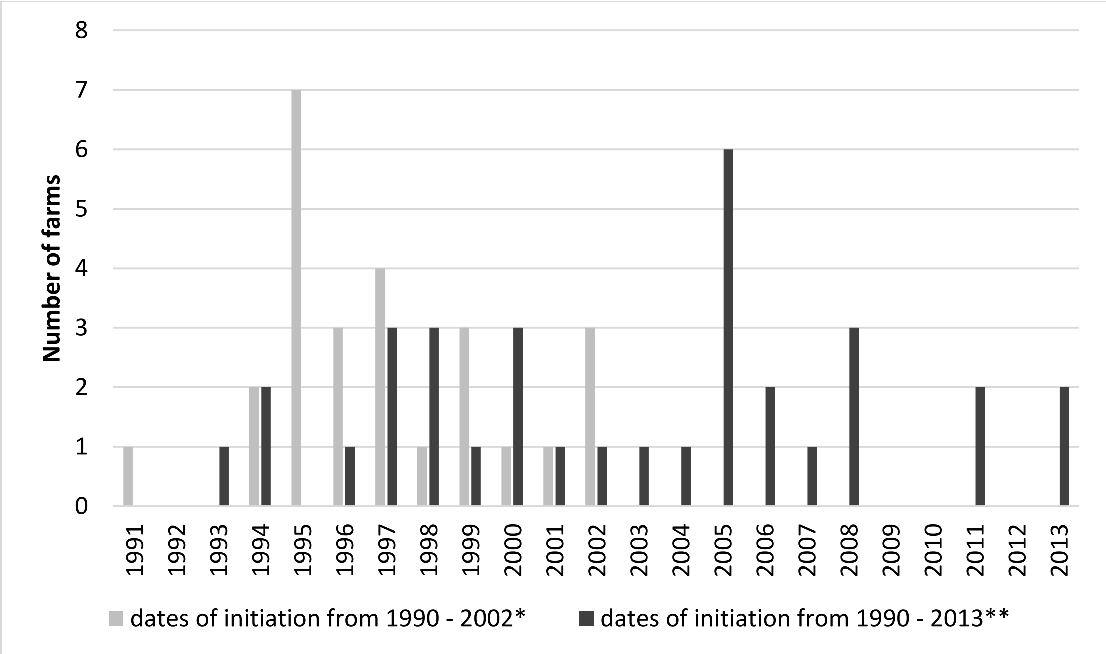

Figure 9.3: Number of farms of the medium- and large-scale horticulture sector and their respective year of initiation of horticultural production NW of Mt. Kenya. (*source: Schuler 2004, 79, n=26, no data=3. **source: field survey 2013, n=34, no data=1.)

Over the full period from 1991 to 2013, an average of 2 farms opened per year in the study area, with higher growth in the first decade of roughly 2.2 farms (n=26) against 1.6 farms (n=18) in the second decade. Multiplying these figures by the average area under horticultural production, 39 ha, gives an average annual increase from 1991 through 2013 of the area under horticulture of 74.1 ha.[19] The first decade again shows a higher growth rate with an average of

[18] In one case, two farms, E27.1 (C19) and E27.1 (C21), were sold to one company. In another case, former company C17 (now E15) sold some of its land, C17.3 and C17.4, which are now different companies, E10 and E12.
[19] The average area under horticulture per farm is 39 ha in the first decade from 1991 – 2002, and 39.5 ha in the second decade from 2003 – 2013 (see chapter 8.1), hence, for the overall value it was calculated with 39 ha.

85.8 ha in contrast to the 59.3 ha from 2003 through 2013.[20] After 2002, the sector seemed to stabilize, with only one farm opening per year. However, the year 2005 marked another boom of new horticulture farms in the study area. Contrary to what one may assume, these were not flower farms riding the floriculture high, but vegetable farms. Four out of the six farms (two of which appertain to the same company) are large-scale vegetable exporters between 20 ha and 60 ha, and two are outgrowers between 15 ha and 25 ha. The following years show slower growth of three or fewer farms opening per year, with no new starts in 2009, 2010, and 2012. The years 2009 and 2010 marked, as seen in chapter 7, a stagnation period in the Kenyan horticulture industry due to high oil prices, bad weather, and a weak Euro. In total, 18 new farms were established since the beginning of 2003. Half of these are vegetable farms,[21] seven are flower farms,[22] and two farms only plant herbs. Although some vegetable farms do also cultivate herbs, these two farms became the first to plant only herbs and therefore present a rather new development in the study area.[23]

The following chapters 9.2 and 9.3 discuss the enabling factors for commercial horticulture in the study area, as well as the restrictions and difficulties the sector has experienced. These findings are based on results from interviews held during the 2013 field survey. Schuler's thesis offers further details and results from the field survey 2003. In some rare cases, I felt that past developments analyzed in Schuler's thesis are still important to understand the sector's current development. Therefore, I included these developments even if the aspect did not emerge from the interviews held in 2013. Most findings from 2013 overlap with those from 2003. The statements came from individual farms; they were subsequently aggregated to the sector level based on the assumption that the full sector's development is a function of its discrete elements. Thus, the qualitative evaluation of the data below concerns the sector, and not any single farm.

9.2. Enabling Factors for the Commercial Horticulture Sector

Various factors on different levels enabled the growth of commercial horticulture northwest of Mount Kenya. The following chapter first analyzes favorable conditions on the national and international level, and then delves into regional enabling factors.

9.2.1. International and National Enabling Preconditions

The medium- and large-scale commercial horticulture sector northwest of Mount Kenya is linked to the national export horticulture industry. Hence, factors favoring the growth of the national export horticulture business are inherently relevant to the sector in the study area. The

[20] Calculated with an average area under horticulture of 39.5 ha. See section 8.1.
[21] E9, E19.1, E19.2, E20, E21, E24, E26, E27.1, E27.2
[22] E8, E10, E12, E13, E17, E18, E22.2
[23] E6, E25

factors listed below originate mostly from literature, following from information mentioned in Schuler's thesis (2004, 83–87), and indications from interviewed horticulturists in the study area.

Preferential Trade Agreements – the Cotonou Agreement and EPAs

Although trade agreements were not mentioned during interviews, they constitute an important framework for the successful trade relations with Kenya's main consumer market, Europe. Kenya is part of the East African Community, which belongs to the African, Caribbean, Pacific (ACP) group of countries that entertain a special relationship with the European Union (EU). This relationship started in 1957 when the EU signed the first Lomé Convention, thereby committing it to help ACP countries to promote their economic and social development. In 2000, the Cotonou Agreement superseded the Lomé convention. This further granted ACP countries' products preferential access to European markets, namely offering non-reciprocal, duty-free market access. However, this preferential access under the Trade Cooperation Chapter of the Cotonou Agreement expired on 31 December 2007, as the terms of this agreement were considered incompatible with the international trade rules of the World Trade Organization (WTO). The incompatibility stemmed from the discrimination of the EUs other trading partners, which are members of the WTO but not ACP countries, and therefore did not profit from duty and tax exemptions. The WTO only permits this kind of discrimination when two countries or trading blocs sign a Free Trade Agreement, are in a Customs Union, or are under GSP arrangement, which was not the case with the Cotonou Agreement. In order to grant ACP countries further duty-free market access to Europe, the EU concluded new WTO-compatible trading arrangements, which progressively removed barriers to trade between the EU and ACP countries and enhanced cooperation in all areas relevant to trade. These arrangements, referred to as Economic Partnership Agreements (EPAs), were implemented on 1 January 2008, and ensure Kenyan growers have tax-free access to European markets today (East African Community EAC 2010). EPAs are a tool of the system of global agricultural trade and liberalization; hence, they fit into the concepts of agro-industrialization as discussed in chapter 3.3.

Increased Market Demand and Quality of Transportation Infrastructure

The commercial horticulture industry northwest of Mt. Kenya is still growing, although not as quickly as in its first decade. As elaborated chapters 7 and 8, market restrictions for vegetables have become tighter and more difficult to meet. Therefore, many exporters consolidate production on their own farms in order to guarantee control over processes. However, market demand for flowers is on the rise, specifically for high quality, large-headed Hybrid-Tea roses. Returns per square meter are high and favor investments in the sector (Interview E9). The study area has ideal growing conditions for these large-headed flowers, as we will see further below. Additionally, Kenya's different altitudes can ideally produce the wide variety of flowers demanded on the market. Moreover, production costs in Ecuador and Colombia, the other two major producers of high quality roses, have increased. Due to this increase, it has become more difficult for them to supply the European market, therefore creating openings for Kenyan products, especially those originating from the study area, where conditions for Hybrid-Teas are ideal.

> "[…] I think previously Kenya has been focused on a European market, an auction product, okay. And now, the rising cost of production in Columbia and Ecuador have meant that actually the pricing of Hybrid-Tea Roses has now got very high. The productivity of Hybrid -Tea Roses was always [low, so it was] better to grow medium roses and to grow lots of them because the price was slightly static. Now there is a good market segment, which is [sic!] improved in the high value Hybrid-Tea's and that is what I think has caused the expansion in this area. We are competing directly with Ecuador and Colombia, right? We are not really competing with or we are not really producing the same produce as the rest of Kenya. So, it's a different product, it's a different market niche." (Interview E7)

At the same time, Dutch rose production has also almost completely vanished, mostly due to high production costs in terms of labor and energy with the need to heat their greenhouses (E8, E12, E18, E22, E23). This has further increased demand for Kenyan roses, as illustrated by the following quote from interview E8:

> "When the airport burnt down interesting statistics came out. 70 % of all flowers, or is it roses? Anyway, that are sold in Europe came from Kenya. […] Now it is probably even more than that because what they weren't counting is that the Kenyan ones coming through the auction, which is [sic!] often counted as Dutch. So it's a major world player. And South America, the wages, the transport costs are going up and they can't afford or they're beginning to find it too expensive to get it to Europe. So the European market is getting bigger and bigger. The advantage of Kenya is that you can get all the different types of flowers and roses from Kenya, so you can get all your requirements from Kenya. Because you have your high altitude, your medium altitude your low altitude, so you get your whole stock from one country. So that is a terrific advantage." (Interview E8)

Nonetheless, profitable commercial production would not be possible were it not for strong transportation infrastructure. First, there is a tarmac road from Timau/Nanyuki to Nairobi, enabling easy truck access between the various farms and the airport in Nairobi. Second, in 2012 the Thika-Nairobi super highway opened. It is an eight-lane highway from the outskirts of Thika to Nairobi that considerably lessens traffic congestion, and thus facilitates access to the airport. Third, different specialized companies organize airport services and infrastructure very well, and include cold storage facilities for the often highly perishable products. Fourth, there is sufficient cargo airfreight from Nairobi to various European destinations at a reasonable price. This used to be a major bottleneck for the commercial horticulture sector, as companies had to buy cargo on passenger planes in the sector's early days (Schuler 2004, 83). Thus, good access to the cargo facilities in Nairobi and sufficient air cargo space have done much to bolster

Kenya's strong position in the international horticulture market. The Kenyan government is constructing a commercial airport in Isiolo, which is just over an hour away, in order to open up development in northern Kenya. The successful construction and operation of this airport could lead to a considerable reduction in transportation costs for horticulture farms in the study area, and thus attract further investment.

The Kenyan Government's Role in the Horticulture Business

The commercial horticulture industry in Kenya, and specifically in the study area, is driven largely by the private sector. The Kenyan government has generally been reluctant to control the sector in the way it controls other agricultural export industries, like coffee and tea (McCulloch et al. 2002, 4; Schuler 2004, 84). The government's liberal economic attitude toward the horticulture industry is widely accepted as a key to the industry's success (Schuler 2004, 84; Rikken 2011, 13). The Ministry of Agriculture is the lead agent concerning aspects of agricultural transformation in Kenya. In 2012, the government adopted a *National Horticulture Policy*, which shows continued government recognition of the role of horticulture and, specifically, floriculture in Kenya. It states that the goal of any government intervention should be to accelerate and sustain the growth and development of the horticulture industry. This translates into a perpetual exemption from VAT (Value Added Taxes) and customs import duties on inputs (greenhouses, greenhouse covers, and cold chain systems), which constitutes a major incentive to attract new investment (Rikken 2011, 12). Another important player is the Horticulture Development Authority (HCDA), a para-statal body. Its mandate is to facilitate the development, promotion, and regulation of the horticulture industry in Kenya. The organization specializes in horticultural information services, providing horticulture production and trade data, and focuses strongly on its regulatory duties (Rikken 2011, 14). Thus, the Kenyan government created an environment where commercial horticulture can thrive without the state directly intervening in the industry's activities.

Agricultural Market Liberalization Following URAA and the Reform of the Kenyan Cooperative Creameries (KCC)[24]

In 1995, Kenya signed the Uruguay Round Agreements on Agriculture (URAA) of the World Trade Organization. Consequently, market liberalization followed and allowed imports of agricultural goods while reducing agricultural subsidies for Kenyan farmers. This led to a decline

[24] This paragraph is summarized from Schuler's (2004, 84–87) thesis, as it explains why so many farmers were originally ready to give up their current activities in order to venture into horticulture. Some interviewees during the 2013 field survey mentioned low wheat prices as a motivation to venture into horticulture, however, the various aspects and processes summarized here did not come forth otherwise in the interviews.

in the price of various agricultural products, particularly for cereals. As discussed at the beginning of chapter 9, many of today's commercial horticulture farmers cultivated wheat or barley before venturing into horticulture. Wheat farmers, for example, had guaranteed markets regardless of the quality of their product. With liberalization, such guarantees disappeared, making cereal production considerably less profitable. Hence, at this moment in time, many farmers decided to venture into the horticulture business (Schuler 2004, 84–85). Parallel to this development, the Kenyan Cooperative Creameries (KCC), a commodity-based para-statal body responsible for post-harvest activities such as processing and marketing, experienced increasing problems. The para-statal body clashed in its business objectives with allegiance to the political establishment leading to sub-optimal business practices and great financial losses. The dairy farmers dependent on the KCC experienced considerable delays in, and sometimes the complete loss of, payments, (Schuler 2004, 85). Thus, similarly to the cereal farmers, dairy farmers ventured into horticulture in order to escape increasing economic pressure from their previous business activities. Commercial horticulture had the advantage of operating independently from rainfall while providing regular income. Cereals are rain-fed crops whose yields are highly dependent on rainfall. Additionally, there is a great temporal gap between sowing, harvesting, and selling wheat, which leads to periods with no income flow. Horticultural crops take only three to four months to mature, and because of their high perishability, markets demand continuous supply. Hence, the farmer needs to produce continuously and production steps overlap, eliminating the temporal gap (Schuler 2004, 86–87).

9.2.2. Enabling Preconditions Northwest of Mount Kenya

The previously mentioned conditions are general and apply to the whole of Kenya, as well as to some other East African countries. However, some very specific conditions favored the development of the commercial horticulture sector in the study area northwest of Mount Kenya. They divide broadly into advantageous growing conditions and advantageous socioeconomic conditions. Before outlining details on these advantageous growing and socioeconomic conditions northwest of Mount Kenya, it must be reiterated that the study area covers a wide altitudinal range, and consequently, various agro-ecological zones. Thus, growing conditions often vary greatly within the territory. However, the study area is considered as an undivided entity, and thus the statements below should be understood as general declarations. Moreover, this is an aggregation of the advantageous conditions mentioned by farmers operating in different parts of the study area, and they may not completely represent the complexity of the natural and socioeconomic environment in the study area.

Advantageous Growing Conditions for Commercial Horticulture

Kenya's main advantage for horticultural production is its position on the equator. This allows for year-round production of crops in demand coupled with ideal 12-hour daylight. This links to other factors in the study area, which further favor the successful cultivation of some horticultural crops.

Climate and altitude: The main advantages of the study area are, as mentioned by 89% of the interviewees,[25] the climate conditions linked to the altitude. Medium- and large-scale horticulture farms are located within an altitudinal range of approximately 1700 m.a.s.l. and 2500 m.a.s.l. The climate there is cool and dry, but still hot enough for horticultural production. The cooler night temperature compared to other areas in Kenya, with a constant temperature from 8°C to 10°C, offers a particular advantage for growing some horticulture crops such as peas, beans, and roses. The daytime temperature remains warm at around 25°C. The dryness of the climate is due to the rain shadow provided by Mount Kenya. Thus, horticultural farmers can control water inputs more easily according to crop requirements, using available surface or ground water. The cool and dry climate also has the beneficial side effect of low pest pressure, reducing necessary pesticide inputs. Concurrently, the relative dryness of the area favors the cultivation of roses: combined with the high altitude, the climate produces the large-headed roses desired by customers, as interviewee E5 underlines:

> "This region is THE most fantastic big Hybrid-Tea growing region. We call it the Bordeaux of Kenya because it's just at the perfect altitude, it's not too high, the weather is fairly temperate, it doesn't get too hot, and we've got fairly cool nights but day temperature is always about 27 [°C] on average. We've got the elevation, also the weather and the rain which are coming from the mountain and then we've got Isiolo which is just up the road here, which gets more of a southern type of hot air coming in. So that, that climate that it creates it's just perfect for growing quality roses." (Interview E5).

The comparably colder climate in the study area results in a slower growth of horticultural crops. Although this leads to lower yields, crops are of higher quality than those grown in hotter areas of Kenya, such as Naivasha. Large-headed roses, for example, are grown at high altitude due to the positive climate effects. Growth is much slower in cooler temperatures, and therefore, the leaves can assimilate more sunlight and grow longer stems and larger flower heads. There are few areas in the world where these conditions are met. Thus, the study area has an economic advantage, as high-quality crops are preferred by customers and result in higher market prices (various interviewees, e.g. E1, E4, E15, E23).

[25] E1, E2, E3, E4, E5, E6, E7, E8, E9, E11, E12, E13, E14, E15, E16, E17, E18, E19, E20, E21, E22, E24, E26, E27, E28

> "The higher the altitude, the higher the quality, but the lower the yield. But your returns end up pretty much the same. Because what we lose on the yield we gain on the price per stem." (Interview E16)

Availability of water resources. Commercial export horticulture in Kenya is based on intensive irrigation schemes, due to market orientation (the European winter overlaps with the dry season in the study area) and crop choice. The study area profits from two solid rainy seasons, in addition to a number of perennial tributaries of the Ewaso Ng'iro passing closely by current or potential horticulture sites. Additionally, in recent years, vast amounts of underground water have been tapped, increasing independence from rainfall and rivers.

> "The expansion of flower farms is directly linked to the discovery of underground water sources. The discovery of underground water created the opportunity, together with the altitude, for flower farms to come in and produce quality flowers." (Interview E25)

Thus, the study area meets the requirements of water availability needed for irrigated agriculture, a comparative advantage mentioned by 46% of the interviewees.[26] However, horticulturists are aware of the rivers' finite character and use increasingly efficient technologies like drip irrigation, in addition to trying to get their water from alternative sources, such as boreholes and water storage. The shift from vegetable production to floriculture is positive in this sense, as flowers require less water and greenhouses allow for rainwater harvest, as illustrated in the following quote:

> "Water as a resource has become much more precious than it was and much more finite than it was. Your requirement on floriculture is much less and the fact that by bringing up a greenhouse you can collect anywhere between 50-55% of your water requirement of the roof. You can also control your water on the crop. So during the rains you won't get those heavy rains on your crop, so you have much higher value crops, on much less land with half the water requirement. It's just common sense." (Interview E32)

Availability of large and fertile land resources: The availability of land is an essential requirement for any type of agriculture. The study area has abundant large, continuous, and fertile land resources, a factor mentioned by 50% of respondents.[27] This links directly to the region's historical background, when colonial-era white settlers occupied large farms and ranches. Although many of these were sold and subdivided after independence, some impressively large farms remain in the study area (see chapter 1). Given sufficient market demand, it is more profitable for a company to produce on contiguous grounds than on a number of smaller plots. It is also relatively easy to purchase land in the study area, as summarized by respondent E27:

> "There is no political patronage: If you look at Kenya, it's a willing buyer – willing seller scenario, even when it comes to land." (Interview E27)

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[26] E3, E7, E9, E10, E11, E12, E18, E19, E20, E21, E24, E25, E27
[27] E1, E2, E4, E8, E9, E10, E11, E12, E14, E18, E22, E24, E26, E27

Apart from land size, the soil fertility is also very important in order to produce profitably. Most commercial horticulture farms are located on the lower mountain slopes, where acrisols and luvisols are predominant. Both have a high water storage capacity, high (acrisols) to very high (luvisols) fertility, and high (acrisols) to very high (luvisols) erosion if not covered. Some farms are located on the lower parts of the study area in the Laikipia Plateau, where climatic conditions are semiarid and black cotton clay soils (vertisols) are widespread. Vertisols offer very high water storage capacities and fertility, but also low erosion if not covered. They are also found in depressive landforms on the lower mountain slopes (Liniger et al. 1998, 34). In sum, they are deep soils with high water retention, high fertility, and good workability.

Advantageous Socioeconomic Conditions for Commercial Horticulture

Availability and cost of labor: Horticulture is a labor-intensive occupation. Vegetable farms employ roughly five people per hectare, and flower farms require fifteen to twenty people per hectare. Furthermore, all flower farms have their processing unit and packhouse on-farm, as do an increasing number of vegetable farms that previously outsourced them to Nairobi in close range of the airport. Packhouse work requires an additional, significant amount of labor.[28] Thus, the availability of sufficient workers is a very important factor. 54% of the interviewed farm managers or owners stated this as a large advantage in the study area.[29] Moreover, many workers own their own *shambas* and therefore have some agriculture expertise, though most are inexperienced with horticultural crops. In addition, since the horticulture industry has now existed for more than twenty years, there is a large pool of trained workers available. A further advantage is that most labor is local, and therefore there is little turnover compared to other areas in Kenya like Naivasha, where most of the labor comes from migrant workers who eventually leave to return home. The embedded nature of the labor force in the study area favors trusted employee-employer relationships, and interviewees generally stated that the labor force was hardworking and productive. Furthermore, labor in the study area is relatively cheap compared to other areas in Kenya such as Nairobi, which lowers production costs for the company and increases the study area's comparative advantage. However, there are strong variations in terms of labor availability depending on farm location. Population density in the Upper Ewaso Ng'iro North River Basin is highest along the tarmac road from Nyeri, passing by Naro Moru, Nanyuki, and Timau, towards Meru, but it decreases toward the north. Accordingly, farms situated along that tarmac road profit from an abundant labor force so much so that there is a steady stream of people who approach the farm gate to inquire about jobs. If a company in this

[28] No specific numbers available
[29] E1, E3, E4, E5, E6, E7, E14, E17, E19, E20, E21, E22, E24, E27, E28

area is in need of new workers, word of mouth is often sufficient. Interviewee E11 describes the situation as follows:

> “We just say we need some workers [to our employees], then 300 would people come to the gate. […] [W]e tell them that we need ten more people and sadly, there'll be 300 people out there. You put a big hat up, put all their ID cards in the hat, and just pull out the first ten.” (Interview E11)

Contrastingly, farms located farther north struggle to find a sufficient workforce to produce in line with demand. Nevertheless, this shortage is often temporary and linked to periods in the year when workers prepare their own land. However, since the bulk of the farms is located along the aforementioned tarmac road, most farms do not experience any problems with labor acquisition.

Thus, the study area fulfills many key requirements that are highly important for a horticultural farming system, including climatic conditions, quality and size of land resources, availability of water for irrigation, and availability and cost of labor. The composition of these factors all determine if a business in a specific location will run successfully and economically. In the study area, the composition of these main factors is generally favorable for horticultural enterprises. However, there are variations of these compositions depending on the precise farm location within the study area.

9.3. Constraining Factors for the Commercial Horticulture Sector

Despite the many factors favoring the establishment and development of medium- and large-scale commercial horticulture in the study area, there are elements that limit the sector’s opportunity for growth. Some of these constraints distinctively link to the establishing stage of the farms; others arose along the companies’ development paths. Hence, this section is divided into initial stage constraints and present stage constraints.

9.3.1. Initial Stage Constraints

Companies establishing commercial horticulture farms in the study area faced a number of limitations (see Table 9.1). The two major constraints in the study area are the availability and quality of labor (mentioned by 46% of horticulturists interviewed) and the availability of water (mentioned by 39% of horticulturists interviewed). While this seems to contradict the above statements indicating both of these factors were enablers, if one differentiates the statements, the truth becomes clear.

Availability and quality of labor: As mentioned before, some of the northern farms are in less densely populated areas. In these cases, there is greater competition with small-scale farmers during planting season, when people tend to their own *shambas.* In addition, during the establishment phase of senior farms, the population density in the study area was lower, causing initial labor shortages. However, farms often attract people from outside areas. Since workers do not have their own means of transport, and not all of the companies provide transport to and from their farms, workers must live relatively close to commute to work each day by foot. If a farm is situated apart from existing localities, it may take a while before enough people migrate closer to the location to work on the farm. While this bottleneck could be resolved by providing bus transport to pick up workers at specific locations, this translates into an additional cost for the company at a moment in the business cycle when other major capital investments eat up a significant amount of finances. Second, even if labor is available in abundance, workers are not always well trained. Most of the people living in the study area own a small plot and are not used to being employed; it requires a readjustment to transition from being one’s own boss to being one of many employees. Reliability is often a big issue at the beginning of this transition. Concurrently, many horticultural crops are different from what people cultivate in the study areas, thus necessitating training to tend to the new crops, which in turn requires time during which the companies cannot grow their investment.

Availability of water: There is a consensus among the various farmers that water demand exceeds above water availability. However, there is also a consensus that proper water management goes a long way toward solving this problem. Hence, the constraining factor of water availability is not that there is no water, but about how to bring water to the farm. The most widespread irrigation system in the study area is drip irrigation, and many farms have their own water storage. This infrastructure requires large investments: in particular, the building of water storage infrastructure slows down the initial development of a farm and devours a lot of finance. These two major factors that the interviewees consider constraining directly link to the other constraining factors of finance and starting capital (mentioned by 28% of the interviewed horticulturists) and insufficient infrastructure (mentioned by 22% of the interviewed horticulturists). Gathering capital to invest in infrastructure and start a business has not been easy in the past. However, building a dam and greenhouses is very capital-intensive. Additionally, many farms are not located directly on the tarmac road, but offset from the main road. Thus, oftentimes a road must first be built to the future farm area. The same is true for electricity, which seldom already exists in new farm areas. Buildings must then be constructed and machines and material brought in, sometimes from Nairobi or even further away.

Initial Stage Constraint	Flower Farms (%)	Vegetable Farms (%)	Herb Farms (%)	Total (%)	Codes of Enterprises
Availability and quality of labor	18%	21%	7%	46%	E1, E2, E5, E6, E10, E12, E14, E19, E21, E22, E25, E27, E28
Availability of water	21%	11%	7%	39%	E3, E4, E5, E6, E8, E11, E14, E18, E22, E25, E26
Finance and starting capital	21%	7%	0%	28%	E1, E5, E7, E8, E12, E14, E20, E22
Insufficient Infrastructure	11%	7%	4%	22%	E6, E13, E14, E22, E26, E28
Bureaucracy	7%	4%	4%	14%	E6, E8, E18, E24

Table 9.1: Factors constraining the development of commercial horticulture NW of Mt. Kenya during their initial stages according to their importance, companies mentioning them, and expressed in % of the interviewed horticulturists. Mixed farms are attributed to their dominant crop category (source: field survey 2013).

Hence, horticulture is a very capital-intensive business, and credit is difficult to obtain. Bureaucracy serves as a further impediment, with 14% of the interviewed horticulturists considering it constraining and aggravating because of the various requirements and licensing that one must obtain.

9.3.2. Present Stage Constraints

The most limiting factors in the development of commercial horticulture northwest of Mt. Kenya at the present stage are various constraining aspects of the consumer market, according to 57% of the interviewed horticulturists (see Table 9.2). European market demand is inconsistent and erratic. The financial crisis of 2007-08 continues to have a negative impact on sales. Market developments are complicated, and the various companies constantly try to find niches where they can sell their produce. However, margins are shrinking increasingly tighter, and returns smaller, as competition increases. This is the case for both vegetable and flower farms. Nonetheless, the floriculture subsector is expanding strongly at the national level, forcing various Kenyan regions to compete with one another. Concurrently, competition with Ethiopia and Tanzania is becoming fiercer. A strong disadvantage for horticulturists in the study area – and Kenya in general – is the fact that they have little to no influence on the market, as their main consumers are in the distant European market.

The second present limiting factor is, again, the availability and quality of labor (mentioned by 44% of the interviewees), especially for vegetable farms. There seems to be increasing competition between flower and vegetable farms, with workers preferring employment in the floriculture sector. This links to the fact that there is little seasonality in flower farming, whereas vegetable farms have clear high and low seasons. Thus, employment on flower farms is often permanent, giving workers greater security. Employment on vegetable farms tends to be more seasonal, and thus less reliable. Furthermore, various vegetable farms in the study area have moved their packhouses from Nairobi onto their farms in the past three years; this has significantly increased the workforce. Additionally, as mentioned before, many workers need to tend to their own plots during planting seasons, and they are thus not available to work on the horticulture farms. This is problematic for the horticulture companies, since workers sometimes do not inform them of this, and simply do not show up. This links to the quality of labor: work ethic is an ongoing problem, in addition to the lack of horticultural experience. Apart from general workers, it is rather difficult to find good, reliable management with sufficient experience and expertise.

In 2003, water availability was the single most constraining factor in the horticultural sector in the study area. In 2013, 39% of the respondents indicated water availability as a limiting factor. Since Schuler's research, vast groundwater reserves have been tapped, granting growers in the area some independence from rain and surface water. However, the increasing number of farms worries some of the longer-established horticulture companies, as they increase pressure on surface and underground water resources. In a long-term view, water availability and management will be the most crucial element for the commercial horticulture industry northwest of Mt. Kenya.

Present Stage Constraint	Flower Farms (%)	Vegetable Farms (%)	Herb Farms (%)	Total (%)	Codes of Enterprises
Market demand and conditions	32%	21%	4%	57%	E1, E3, E4, E5, E7, E10, E11, E12, E13, E14, E15, E16, E18, E21, E23, E27
Availability and quality of labor	11%	21%	11%	44%	E1, E2, E3, E6, E10, E14, E19, E21, E22, E23, E25, E27
Water availability	11%	25%	3%	39%	E1, E2, E4, E8, E9, E16, E19, E22, E24, E25, E26
Infrastructure and logistics	22%	7%	7%	36%	E6, E9, E10, E11, E12, E13, E14, E22, E25, E26
Role of government	15%	7%	7%	29%	E1, E3, E5, E6, E7, E10, E12, E23
Increased cost of production	11%	14%	4%	29%	E1, E3, E10, E14, E16, E25, E26, E27
Supermarket requirements	7%	14%	0%	21%	E1, E7, E11, E21, E24, E27

Table 9.2: Present (2013) factors constraining the development of commercial horticulture NW of Mt. Kenya according to their importance, codes of enterprises, and expressed in % of the interviewed horticulturists. Mixed farms attributed to their dominant crop category (source: field survey 2013).

Infrastructure and logistics are another persistent problem, as mentioned by 36% of respondents. On the farm level, this translates into the building of roads, accessing and/or generating electricity, and ensuring water supply through water storage, irrigation systems, and more. The distance to Nairobi offers a further issue: many farm inputs and technical backups for infrastructure and machines are only available in the capital; and fragile and perishable crops must be sent to Jomo Kenyatta Airport (JKA) in the proper conditions. All these aspects are part of farm management, and need to be organized and planned carefully and precisely. Furthermore, fuel prices directly determine a large amount of the profitability of export produce. If fuel prices climb too high, airfreight becomes too expensive to allow for profitable exports.

Although the sector's success can largely be attributed to government non-interference and a dynamic private sector, 29% of the horticulturists in the study area say they would appreciate more support from the government. They feel that since horticulture is one of the major sources of foreign currency and drivers of the economy, the government should do more in terms of tax breaks and lobbying. As an example, horticulturists receive large tax bills on the construction of large water storage facilities. Moreover, although the sector is VAT-exempt, horticulturists must pay the tax first and receive government reimbursement later, which takes approximately two years. This wait is a great source of frustration. Additionally, with the rise of horticulture in Ethiopia and Tanzania, many farmers believe that the government should offer more incentives in order to prevent a drain of horticultural companies into these neighboring countries, where labor is much cheaper than in Kenya. Generally, there is a consensus that the government does not interfere with the industry, but it does not help it either.

Another constraint is the increased cost of production (mentioned by 29% of interviewees), mainly linked to the increased cost of power and inputs and climbing wages due to increased competition between the growing number of farms in the study area. The increased cost of production on vegetable farms is mainly linked to more stringent requirements from EU supermarkets regarding chemicals maximum residue levels (MRLs), labor welfare, and more, coupled with strong price pressure. If one does not comply with these requirements, the risk of produce being rejected is very high. The general requirement from European supermarkets for market-based certifications and social or environmental labels represent a cost for the company (mentioned by 21% of the interviewed horticulturists).

Other growth-restraining factors that presently hinder the future development of the commercial horticulture sector are:

- pests and diseases (interviews E1, E3, E10, E18, E19);
- the unpredictability of the climate in both Kenya and consumer markets; e.g., good European summers reduce market demand as Europe promotes its own produce (interviews E10, E12, E13, E18);

- increasingly difficult access to finance for larger investments, such as water storage dams, since the financial crisis, as banks are very reluctant to give out credit (interviews E7, E13, E14, E25);
- security, as in all of Kenya, presents risks and requires all of the farms to invest in security personnel (interviews E6, E7, E11).

As has been shown, most of the factors constraining the sector in its initial stages continued to create problems in subtly different forms. For example, the infrastructural issues extend from the farm level in its initial stages to the access of backup and inputs in, and the transport of produce to, Nairobi. Other factors become less important, like access to finance, as most large investments take place in the stages of the sector. However, some limiting elements persist unequivocally, such as the availability and quality of labor and the availability of water.

9.4. Entering and Exiting Commercial Horticulture

This subchapter addresses the motivation behind farmers' decision to venture into horticulture. Furthermore, it presents the result from the two interviews with former horticulturists, analyzing why they decided to abandon their horticultural business venture.

Commercial horticulture is a profit-driven business based on foreign currency. The main reason that 69% of respondents listed as a motivation to venture into commercial horticulture is the generation and stabilization of income by securing or maximizing the profitability of the land.[30] Horticulture is a viable business and the market situation is very strong compared to other agricultural goods, especially for floriculture. There are various ways for one to open a horticulture farm in the study area. Some farms are established from scratch as outgrower farms, while at other times a national export company will decide to open up its own farm in the study area, (e.g. E10, E13, E18, E19, E22.2, E24, E26, and E27, which are all branches of a major company and were started after 2003). Another 21% of the interviewees declared self-employment as their reason for venturing into horticulture.[31] These cases are most often former employees of already existing medium- and large-scale horticulture farms with valuable horticulture expertise who decided to start their own horticulture business. A further possibility is that an already existing farm converts part of its land to commercial horticulture, either as an outgrower after being approached by an exporter, or as an exporter itself. In this case, the reason to venture into horticulture is mostly diversification, as another 10% of the respondents indicated, in order to spread the risk and use their land.[32] Former horticulturist E31 states this as the main reason

[30] E1, E3, E4, E5, E6, E7, E9, E10, E11, E14, E15, E16, E19, E20, E21, E22, E24, E26, E27
[31] E2, E8, E12, E14, E17, E25
[32] E1, E4, E15

behind why he ventured into horticulture, as illustrated by the following quote from his interview:

> "You know the most important part of being an agronomist in modern day Africa is that you've got to utilize every bit of land, if you're not, well, you shouldn't have it." (Interview E31)

Concurrently, they often cultivate cereal crops and conduct livestock farming. However, regardless of how a farm is established within the horticulture industry, the principal motivation of famers and horticulture companies is to generate new or additional income in a nationally promising and growing agricultural branch. Despite the rather positive conditions for commercial horticulture in the study area, various farms have quit the horticulture business completely since 2003, most of them outgrowers. The reasons behind this cessation were initially not intended for inclusion in this thesis. However, once in the field, the opportunity to interview two former horticulturists arose (E31 and E32). Both interviewees were former outgrowers of approximately 16 ha. They both already owned their own farms, and both cultivated cereals and kept livestock. They took up horticulture to diversify and gain additional income, or, as E31 succinctly summarized, "Your eggs were just in different baskets." An exporter who needed more produce than what his own farms yielded contacted them both to initiate horticulture on their farms during the 1990s. However, E31 and E32 stopped these activities in 2008 and 2010, respectively. They offered three main reasons: (1) supermarket price pressures coupled with stringent requirements, (2) problems with water availability, and (3) soil degradation and, subsequently, lower yields. These three factors combined and coupled with an often-difficult relationship with the exporter that resulted in higher costs than benefits, whereupon both companies decided to exit the horticulture industry.

9.5. Summary: Development 2003 – 2013

From 1991 to 2013, an annual average of 2 farms opened, increasing the area under cultivation by approximately 76 hectares each year. There was higher growth from 1991 to 2002 than from 2003 to 2013, when the growth rate was slower as illustrated in Figure 9.4. During those twenty years, there were two periods of major growth. The first period lasted from 1995 to1998, when fifteen farms opened in the study area, accounting for roughly 55% of the farms established through December 2002. Homegrown (K) Ltd. played a major role in this growth as it owned six farms at the time, four of which opened in that time span. The second period of major growth was between 2005 and 2008, when twelve new farms started in the area northwest of Mount Kenya, accounting for approximately 34% of the total number of farms in the study area at the time of the 2013 field survey and accounting for 83% of the farms opened since January 2003.

Despite the expansion of floriculture at this time, this growth came mostly from vegetable farms (seven) and not flower farms (four, in addition to one herb farm).

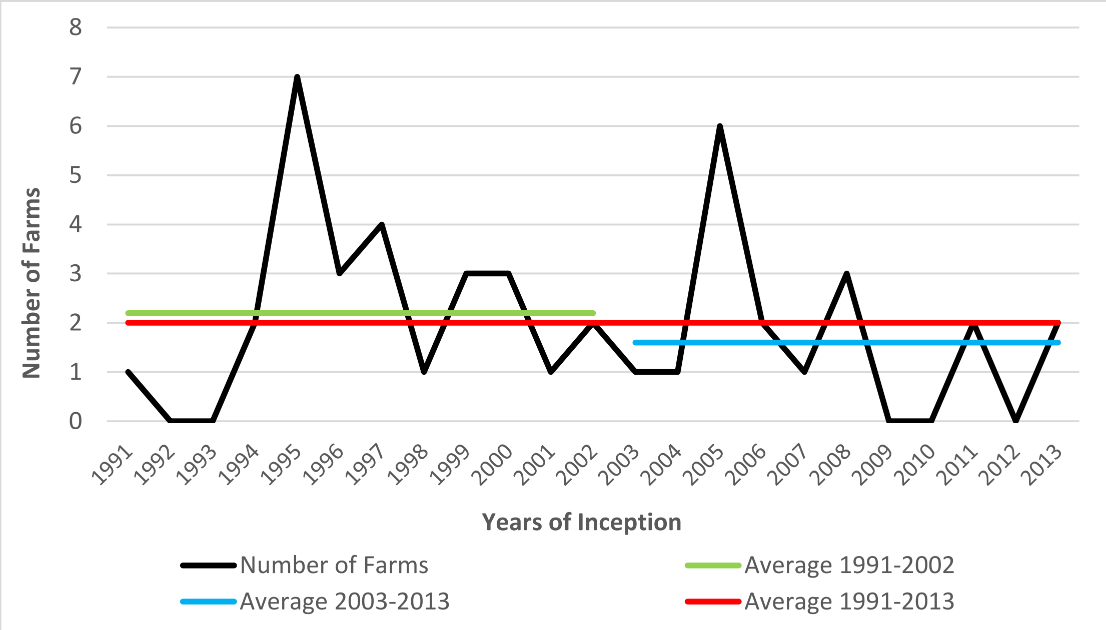

Figure 9.4: Years of inception of commercial horticulture farms NW of Mt. Kenya (Source: Schuler 2004:79; field survey 2013)

Various factors on the international, national, and regional level **enabled** the growth of commercial horticulture northwest of Mt. Kenya. Interestingly, the important positive factors have hardly changed since 2003, and remain as listed below:

- Increased market demand in Europe
- Good quality of transportation infrastructure
- Preferential trade agreements between the European Union and Kenya
- Agricultural market liberalization
- Governmental non-interference and export incentives
- Advantageous growing conditions in the study area
- Advantageous socioeconomic conditions in the study area

The first five factors are not bound to the study area specifically, but enable commercial horticultural business throughout Kenya. Nevertheless, they are important for the commercial horticulture industry in the study area as well, and the growth of the commercial horticulture sector in the study area is thus inseparably tied to the development of the national horticulture industry. The last two enabling factors, however, are specific to the study area, and are particular environmental and socioeconomic conditions that have supported the sector's growth.

In addition to these favorable factors, other factors **constrain** the future development of the sector. In the initial stage of medium- and large-scale farm establishment in the study area, the two most constraining factors are the availability and quality of labor and the availability of water. Other factors hampering development at the beginning of a farm's establishment are obtaining finance and starting capital, the insufficient infrastructure in the study area in terms of roads and electricity, and heavy bureaucracy. Most of these constraints remain an issue throughout the lifespan of a commercial horticulture farm. Problems with labor availability and quality remain a source for headaches, as do the limited water resources and the resulting need to build infrastructure to get water to the farm through water storage, digging boreholes, or installing weirs on rivers. However, the most constraining factor for medium- and large-scale horticulture companies in the study area, once initial obstacles are surpassed, is the erratic and competitive market itself.

Chapters 8 and 9 showed to what extent, and through what processes, the commercial horticulture sector has grown in the study area. Before 1991, when there was no commercial horticulture in the study area, most existing medium- and large-scale farms produced cereals, such as wheat and barley, and held livestock. These activities are rain-fed, and thus, the quality and quantity of the crop depended strongly on rainfall quantity and rainfall patterns throughout the year. Commercial horticulture is an irrigated activity; crops need a specific amount of water every day. Vegetable crops may be rain-fed during the rainy season when there is sufficient rainfall, but they must be irrigated during the dry season. Flowers are grown in greenhouses, and thus they need irrigation throughout the year. 82% of the land used for horticulture activities today was previously cultivated with rain-fed crops or lay completely idle. Thus, it is safe to assume that the transition of these lands to irrigated activities has had an impact on river water resources in the study area. This potential, and effective, impact of the medium- and large-scale commercial horticulture sector on river water resources is discussed more thoroughly in the next chapter.

10. Implications for River Water Resources

As depicted in chapter 2, there is a steep ecological gradient from the slopes of Mt. Kenya to the semiarid and arid plains of the Laikipia Plateau, and down further to the arid lowlands. Rain patterns also vary greatly. The altitude and direction of the major highlands influences rainfall, in addition to the direction of prevalent moisture-bearing air currents. Hence, the forest areas of Mt. Kenya may see rainfall as abundant as 1500 mm, whereas the arid lowlands around Archer's Post may get as little as 350 mm, as illustrated in Figure 10.1 (Gichuki et al. 1998, 16). Livelihood in these lower areas is therefore dependent on river flows during the dry season. However, the freshwater requirements on the slopes and the footzone of Mount Kenya have increased due to various developments such as land use change from extensive ranching to small-scale mixed farming, substantial immigration, growing urban centers, new tourist resorts, and year-around horticultural production (see chapter 1). Thus, the availability of water in these downstream areas is even more problematic during dry seasons, with decreasing river flows due to increased upstream abstractions (see Figure 10.1). The median decade river flow of the Ewaso Ng'iro River dropped from 9 m^3/s in the 1960s to 0.9 m^3/s in the 1990s to 0.58 m^3/s in 2000, and the river dried up completely in several years, including 1984, 1986, 1991, 1994, 1997, and 2000. Since the year 2000, the dry season river flow has been reduced to a trickle and barley ever reaches Archer's Post in the lowlands (Liniger et al., in press). Concurrently, some perennial tributaries of the Ewaso Ng'iro originating from the northwestern slopes of Mt. Kenya dried up for several days during the dry season, as shown by Aeschbacher (2003, 96) with the Naro Moru River which, in 2002, dried up regularly.

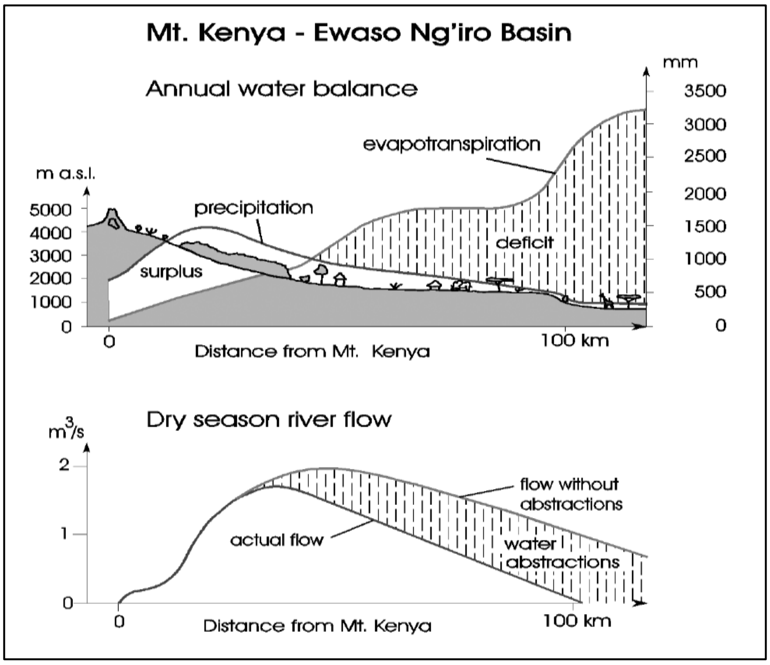

Figure 10.1: Annual water balance and dry season river flow in the Ewaso Ng'iro River Basin. (Source: Liniger & Thomas 1998)

Water scarcity in the Upper Ewaso North River Basin is largely a seasonal phenomenon bound to the dry season, and has become particularly problematic in February, the driest of all months. During that time, the flow of the Ewaso Ng'iro at Archer's Post in the lowlands is highly dependent on contributions from the upper forest zone of Mt. Kenya (Gichuki et al. 1998, 20). However, at the same time, 60-95% of the river water available is abstracted upstream: these intakes become rather influential on downstream water availability in the dryer lowlands.

The commercial horticulture sector revolves around yearlong irrigated crop production for export markets. The sector has experienced rapid growth since the early 1990s (see chapter 8 and Schuler 2004, 57–72), bringing in new and potent water users. Additionally, vegetable horticulture crops destined for European markets are subject to great seasonality, as demand is highest during the European winter, which coincides with the dry season in the study area. Thus, production is highest during these dry months, which in turn implies high water requirements. The seasonality of production has lessened somewhat in recent years with the shift to floriculture, and although water requirements are now constant throughout the year, they have increased in the past decade, as we will see in section 10.3. This pattern of high and constant water demand throughout the year, especially during times of low water availability, raised the questions of where medium- and large-scale horticulture farms source their water; and what quantities of water they use during the dry season. Answering these questions enables the calculation of the impact of commercial horticulture on the depletion of selected tributaries of the Ewaso Ng'iro River during the dry season. Hence, this section focuses on the water use of the commercial horticulture sector in the study area during dry seasons. Water use during the rainy season will not be discussed. The dry season comprises two periods for a total of 180 days, the first from mid-December to mid-March, and the second from mid-June to mid-September. Overall, the goal of the chapter is to give an order of magnitude on the commercial horticulture sector's dry season water use and its impact on the depletion of river water.

10.1. Results from 2003

In 2003, the mean dry season water use of the total commercial horticulture sector on the northwestern slopes of Mt. Kenya was between 357 l/s (W_{emp}) and 567 l/s (W_{dem}).[33]. This translated into mean dry season water use per hectare under horticultural cultivation between 0.5 l/s and 0.7 l/s. On average, the production of a horticultural product during the dry season in the study area required 0.6 l per second and hectare of water. Approximately 90% of the dry season water use in the commercial horticulture sector came from surface water (water storage or direct abstractions of river water during the dry season); groundwater contributed the remaining 10%.

[33] W_{emp} and W_{dem} are empirical theoretical values, calculated by Schuler according to information gained during the field survey 2003 or the *Demand Based Estimate*. See chapter 10.2.

Of the surface water, between 32% (W_{dem}) and 48% (W_{emp}) came from floodwater storage. This stored floodwater from the rainy season contributed considerably to lessen the pressure on river water resources during the dry season. However, between 39% (W_{emp}) and 59% (W_{dem}) of the sector's mean dry season water use was abstracted directly from the upper reaches of the Ewaso Ng'iro River during the dry season. In absolute values, this means that the total sector's dry season river water abstractions ranged between 145 l/s (W_{emp}) and 325 l/s (W_{dem}). Schuler then evaluated the impact of the commercial horticulture sector in the study area on the depletion of median February river flows of four rivers (Naro Moru, Timau, Teleswani, and Burguret) in the decade from 1981 to 1990. He compared the data from this time, just before commercial horticulture appeared in the study area, to the period when horticulture began to develop between 1993 and 2002. Two key findings resulted from this analysis:

Frist, the impact of commercial horticulture on the depletion of the median February flows of the four analyzed rivers varied greatly from river to river as shown in Table 10.1.

River	Contribution to Dry Season River Flow Depletion (W_{emp}) [%]	Contribution to Dry Season River Flow Depletion (W_{dem}) [%]
Naro Moru	6.3%	3.4%
Burguret	no reliable data	no reliable data
Teleswani	39.6%	70.2%
Timau	24.4%	35.8%

Table 10.1: 2003 contribution of the commercial sorticulture sector NW of Mt. Kenya to the depletion of dry season river flow in [%] (Source: Schuler 2004, 122)

The number of medium- and large-scale horticulture farms along the four analyzed rivers was similar. Likewise, the total riparian areas under dry season cultivation, as well as irrigation, were similar among the medium- and large-scale farms abstracting water from four rivers. The differences in the impact of the sector on the heavily depleted median February flows was mainly attributed to varying availability of floodwater storage on these farms. Without the storage of floodwater, the massive demand for water for dry season horticultural production applied severe pressure to river low flows, which had a vast impact on the February flows of the respective rivers (Teleswani River and Timau River).

Second, the median February flows of three of the four rivers analyzed were already depleting before the first medium- or large-scale farm was established in the study area.

- Stakeholders other than the commercial horticulture sector must have contributed to the depletion of February river flows.
- To various extents (see Table 10.1), other river water abstractions contributed decisively to the depletion of the February river flows of the rivers analyzed during the decade from 1993 to 2002.

Another topical focus within the water chapter was how aware the actor-category of commercial horticulturists was of water-related conflicts. Schuler discovered that the horticulturists were very aware of potential water-related conflicts, primarily because they were held responsible for decreased river water flows by other water users. However, as the previously summarized results showed, the medium- and large-scale horticulture sector must not be held solely responsible for the depleted river water resources during dry seasons, although they did apply immense pressure on the river water resources (pressure varies depending on river from 3.4% to 70.2 %, please consult Table 10.1 for details). The storage of floodwater was perceived as a conflict-mitigating strategy by the horticulturists; collaboration with the surrounding communities by either helping to initiate or joining local Water Ressource Users Associations (WRUA) further assisted in resolving conflicts. Jeopardized water security was the major limiting factor for the future development of the medium- and large-scale horticulture in the study area, and therefore, construction of floodwater storage facilities for the supply of water during the dry season can also be seen as a measure to secure the future existence of the respective horticultural farms, and consequently, the commercial horticulture sector on the northwestern slopes of Mount Kenya.

While analyzing Schuler's data, a glitch came to light: company C14 seems to be missing from the analysis. Although the company appears in the inventory, it is absent from the water analysis. Consequently, as one further company refused an interview, the actual sample for the water analysis in 2003 was 23 companies on 27 farms.

10.2. Procedures of Calculation and Evaluation of Data

The interviews included inquiries into each farm's dry season water use, which served as base data for the subsequent calculations to answer the questions about where medium- and large-scale horticulture farms source their water; and what quantities of water they use during the dry season. In addition to river water, some commercial horticulture farms have boreholes to access groundwater; others have water storage to bridge the dry months. Water storage can stem from either rainwater harvest or floodwater during the rainy months, when river flows are abundant. There are also some farms that do not use river water at all, but a combination of groundwater and storage water. Most farms rely on a combination of these different water sources. Thus, to calculate the river water use of individual farms, it was necessary to subtract water use from additional water sources from the total dry season water use of each farm. The result is a calculation in two steps of the amount of river water abstracted per day during dry season for each respective farm **(farm level)**.

The **first step** defines the ideal composition of the *total dry season water use*:

$$Declared\ Dry\ Season\ Groundwater\ Use + Declared\ Dry\ Season\ Water\ Use\ from\ Storage + Declared\ Dry\ Season\ River\ Water\ Use = Total\ Dry\ Season\ Water\ Use$$

However, it is possible that the total dry season water demand is higher than the declared water uses from the different sources.

$$Declared\ Dry\ Season\ Groundwater\ Use + Declared\ Dry\ Season\ Water\ Use\ from\ Storage + Declared\ Dry\ Season\ River\ Water\ Use < Total\ Dry\ Season\ Water\ Use$$

In this case, a modification of the equation incorporating any further available stored water covers the greater total dry season water demand.

$$Declared\ Dry\ Season\ Groundwater\ Use + Declared\ Dry\ Season\ Water\ Use\ from\ Storage + Declared\ Dry\ Season\ River\ Water\ Use + Further\ Storage\ Water\ Availability = Total\ Dry\ Season\ Water\ Use$$

It may be that there is no further storage available or that it does not cover increased water requirements, as demonstrated in the equation below:

$$Declared\ Dry\ Season\ Groundwater\ Use + Declared\ Dry\ Season\ Water\ Use\ from\ Storage + Declared\ Dry\ Season\ River\ Water\ Use + Further\ Storage\ Water\ Availability < Total\ Dry\ Season\ Water\ Use$$

If this third equation does not manage to account for the increased water demand, it is further enhanced as follows:

$$Declared\ Dry\ Season\ Groundwater\ Use + Declared\ Dry\ Season\ Water\ Use\ from\ Storage + Declared\ Dry\ Season\ River\ Water\ Use + Further\ Storage\ Water\ Availability + Undeclared\ River\ Water\ Use = Total\ Dry\ Season\ Water\ Use$$

If the *declared total dry season water use* were to be smaller than the sum of the declared groundwater, storage water, and river water use, then it is assumed that the discrete indications per water source are true and not the indicated total.

The **second step** solves the above equation for the *undeclared river water use* in order to determine the full dry season river water abstractions.

$$Undeclared\ Dry\ Season\ River\ Water\ Use = Total\ Dry\ Season\ River\ Water\ Use - Declared\ Dry\ Season\ Groundwater\ Use - Declared\ Dry\ Season\ Water\ Use from\ Storage - Declared\ Dry\ Season\ River\ Water\ Use - Further\ Storage\ Water\ Availability$$

If the equation for *undeclared river water use* in the **second step** results in negative values, then it is set zero, meaning there is no undeclared water use from rivers. If the same equation results in positive values, then there are further, undeclared, river water abstractions. This procedure allows for the needed flexibility demanded by the two calculation procedures W_{emp} and W_{dem} described further below. Namely, if the total water demand increases, as it does between W_{emp} and W_{dem}, then any possible storage water available first covers this increase. If there is no additional storage water available, then it is assumed that the water is abstracted from rivers. Groundwater use is definite, as boreholes have a fixed pumping capacity per hour. The only insecurity here stems from the indicated pumping hours, which could have been under- or overestimated by the interviewee. However, there is no way to verify these statements.

Consequently, this single farm level data is aggregated in two ways:

(1) To the **sector level:** Mean dry season river water use of all of the medium- and large-scale horticulture farms in the study area is summed. This results in the total mean dry season river water use of the commercial horticulture sector in the study area.
(2) To the **river level:** Mean dry season river water use of all of the medium- and large-scale horticulture farms abstracting water from a specific river is summed. This value equals the mean dry season water use of commercial horticulture along respective rivers, allowing for analysis of the impact of the horticulture sector along specific rivers, for which sufficiently long time series of dry season river flows are available.

In a final step, the river level data is compared to the respective rivers' median February flow in four different decades: from 1961 to 1970, from 1981 to 1990, from 1993 to 2002, and from 2003 to 2008/2012. The comparison of the various decades allows for the evaluation of the impact of commercial horticulture in the study area on the depletion of dry season river flows of the Ewaso Ng'iro. The decade from 1961 to 1970 simulates the natural river flow with little human impact. The period from 1981 to 1990 shows the conditions of February river flows just before the establishment of the commercial horticulture sector in the study area. The third time interval, from 1993 to 2002, covers the decade analyzed in Schuler's research, when commercial horticulture experienced its primary growth. The fourth and final period, from 2003 to 2008/2012, represents the current state, when horticulture and its irrigation activities continued developing at a less exuberant rate as in the previous decade. For two out of the four analyzed rivers, the Timau and Teleswani Rivers, river flow data was only available until 2008 because of continuous theft and vandalism of the gauging stations.

The calculation procedure, illustrated in Figure 10.2 is based on each farm's mean dry season water use. The data stems from the various interviews with farm managers or owners, as well as additional field notes I took. Some interviewees directly specified the amount of water used during dry seasons and the respective percentage originating from river water, groundwater, and storage water (1). However, this was not always the case, and most of the values had to be calculated. This was due to either ignorance of the precise numbers per day or reluctance to divulge the daily quantity of irrigation water used, most likely because of the sensitive nature of this information (see chapter 5.2). Hence, calculations were adapted for each farm when values could not be obtained directly from interview specifications. These calculations were done based on additional interview data (1.1) and general assumptions (1.2), which are detailed further below, in order to obtain the targeted values at the farm level (2). The data obtained from the above two empirically based procedures (W_{emp}) is then cross validated with a theoretical one, the *Demand Based Estimate* (W_{dem}),[34] for all of the farms (3). For the *Demand Based Estimate*, interview specifications such as the number of employees and water uses other than irrigation serve as inputs for the equation to calculate the theoretical water demand of each farm. The primary reason behind the cross-validation is to assess the validity of the interview data and reflect it critically, mainly because of the perceived sensitivity of the water issue for people both within and outside of the horticulture industry. Another reason is the high dependence of the water use calculations on other data from the interviews. Hence, the *Demand Based Estimate* indicates an external estimate of the probable water demand of the various farms.

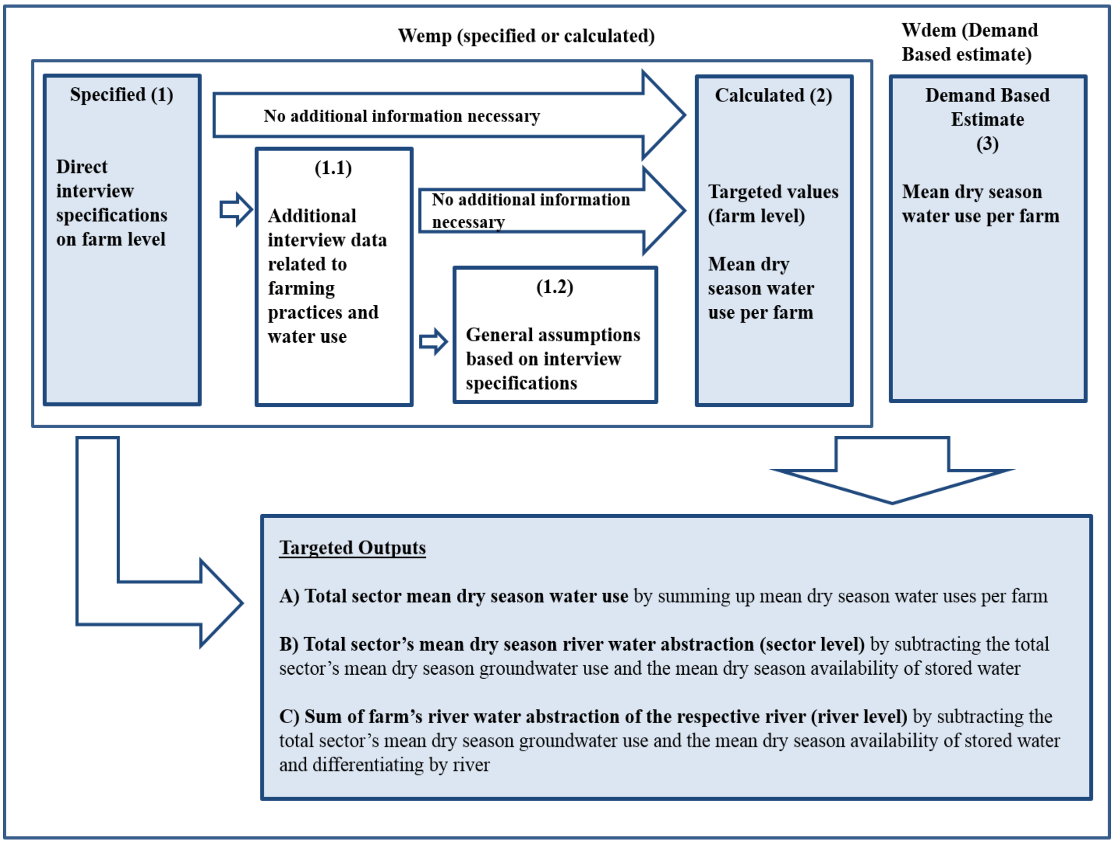

Figure 10.2: Overview of the calculation procedures of mean dry season water use per farm and generation of the aggregated values on the sector and river level (source: adapted from Schuler 2004, 106).

[34] Demand based estimate adapted from MoWD (1986) and Fao (1977) cited in NRM3 (2003, 17)

Details on the three different procedures for gaining a single farm's dry season water use are explained in detail below. They are all in line with Schuler's procedure in order to guarantee comparability between the two studies

(1) Direct Interview Specifications on Farm Level

Water use data given during the interview refers to different, but specified, temporal and spatial units. The list below depicts the various ways in which interviewees communicated their dry season water use:

- **Mean dry season** water use per day and farm [m^3/d], or per day and hectare, under horticultural cultivation [m^3/d*ha].These are the values the study aims to obtain.
- **Mean annual** water use per day and farm [m^3/d], or per day and hectare, under horticultural cultivation [m^3/d*ha]. When these values were provided during the interviews, additional interview specifications were consulted or general assumptions were made in order to derive **mean dry season** water use per day (per farm and per hectare). See the list below for further details.
- Mean water use per day and farm [m^3/d], or per day and hectare, under horticultural cultivation [m^3/d*ha] with **no reference to a specific period**. In order to derive **mean dry season** water use per day (per farm and per hectare), additional interview specifications were consulted or general assumptions were made (see list below).
- **Mean water use per day and water source**. Many farms cover their water needs from different sources. In these cases, further questions clarified the percent distribution between the different sources. Not all interviewees could provide direct information about the amount of water derived from each source in m^3 or percent, but most often from one or two sources. The others were then calculated.
- **Minimum and maximum water uses per day with no reference to a specific period**. Indicated maximum water use per day was considered to equal dry season water use (see 1.2 for details).
- **No indication on dry season water use**. Some interviewees did not give any indication on their water use. In this case, calculations were based on general assumptions as described in 1.2 below.

(1.1) Additional Interview Data Relating to Farming Practices and Water Use

In some cases, the interviewees did not provide any direct information about the farm's mean dry season water use per day (either per hectare or per farm). Consulting additional interview data allowed for calculating the missing or suspected invalid values indirectly, according to the list below.

- Through indications of the farm's water storage capacity and the duration of said storage, the mean dry season water use per day and farm can be derived, assuming that the stored water is only used during the dry season.
- Borehole pumping capacities and the pumping schedules provide an indication of mean daily water use when combined with the use percentage of the source. Most of the data on pumping schedules were from the dry season, thus allowing us to calculate the desired mean dry season daily water use.
- Irrigation activities and the area under cultivation are subject to seasonal adjustments (e.g. increase of irrigation during dry season compared to rainy season). These adjustments allow for a derivation of the mean dry season water use per day from specified or previously calculated mean annual water use per day.

(1.2) General Assumptions Based on Interview Specifications

In some rare cases, the additional interview data was insufficient or deemed invalid for calculating mean dry season water use per day (per hectare or per farm). Where this occurred, two different approaches were available: for some, mean dry season water use per day (per hectare or per farm) was derived from other, similar farms for which specified or calculated values were available. In the remaining cases, mean dry season water use was indirectly determined according to general assumptions that were previously deduced from details in all of the interview answers, as shown in the list below:

- When the interviewee directly specified mean annual water use per day (per farm or per hectare) but additional interview data is insufficient for further calculations, the mean annual values are accepted as mean dry season water use per day (per farm or per hectare). This estimation is conservative because mean water use per day during dry season is likely to be higher than the annual average.
- When an interviewee specified a minimum and a maximum value of daily water use without indicating a specific period, minimum water use is assumed to refer to the rainy season, while maximum water use is assumed to relate to the dry season.
- Crop rotation is assumed to take place on every vegetable farm, even if the interviewee did not specifically state that it is. This assumption rests on field observations and other interview specifications.
- Crop seasons are assumed to last an average of 16 weeks from planting to complete harvesting, if not otherwise indicated. Technically, the duration of a crop season varies widely depending on the horticultural crop and the micro-climatic conditions related to the location of the farm.

- If not specified differently, it is assumed that there are two crop plantings per hectare and year. This assumption is conservative, as three crop plantings per hectare and year are practicable in the study area.
- Predicated on the above assumption of two crop plantings per hectare and year, the mean annual area under cultivation on a vegetable farm is assumed to be roughly two-thirds of each farm's area under horticulture.
- Area under horticultural cultivation is assumed largest during the dry season on vegetable farms due to high market demand and profitability in that period.
- Production on floricultural farms with greenhouses is assumed constant throughout the year.
- Based on the above assumption, water use on floricultural farms with greenhouses is assumed constant throughout the year.
- If not explicitly indicated differently, then stored water is assumed to be used exclusively during dry seasons. The dry season is presumed to last 90 days from mid-December until mid-March, and another 90 days from mid-June to mid-September. However, in between these dates there are rainy seasons that can replenish the water storage facilities. Hence, only 90 contiguous days are considered as a dry season.
- If storage capacity is not specified, it is assumed to comply with the legal requirement of 90 days.
- In some circumstances, companies have different farms and it was only possible to visit one of them. If all of a company's farms had the same or similar crop planting programs, water use from the visited farm was assumed the same on all other farms not visited, unless otherwise indicated.

(2) Targeted Values (Farm Level) – Mean Dry Season Water Use per Farm

Therefore, as Figure 10.2 illustrates, if there were insufficient or no interview specifications (1), additional interview data relating to farming practices and water use (1.1), such as borehole capacity and pumping hours, were consulted in order to calculate the targeted value of mean dry season water use per farm. However, if the additional interview data proved insufficient or too imprecise to calculate the targeted value, general assumptions based on various interview specifications (1.2) were used, such as two crop plantings per year on a vegetable farm. Thus, combining imprecise or insufficient data from direct interview specifications (1) with additional interview specifications (1.1) and, if necessary, general assumptions (1.2), it was possible to calculate the targeted values (2) for every farm as W_{emp}.

(3) Demand Based Estimate

The *Demand Based Estimate* was calculated to cross-validate the data gained from interviews. The procedure used here is adapted from the Kenyan Ministry of Water Development (MoWD) and the Food and Agriculture Organization (FAO 1977) (both cited in NRM3 2003, 17). The equation combines water demand on a farm from four predefined sources, namely, (1) people on the farm (DW_P), (2) livestock (DW_L), (3) on-farm industrial water (DW_{IND}), and (4) irrigation (DW_I). This translates into the following equation, where W_{dem} stands for the demanded water during dry seasons:

$$DW_d \left[{m^3}/{s}\right] = DW_I + DW_P + DW_L + DW_{IND}$$

Daily Water Demand for Irrigation

DW_I [m^3/s] = (A*10’000*ET_O*Kc*[1/ŋ])/(24*60*60)

A = Dry season area under cultivation [ha]

ET_O = Reference potential evapotranspiration = 0.005 [m/d]

Kc = Crop factor = 0.8

ŋ = Irrigation efficiency = 70%

Daily Water Demand for People on the Farm

DW_P [m^3/s] = (N_P*cr_P)/(24*60*60)

N_P = Number of people (mean annual number of employees)

cr_P = Average consumption rate per person = 40 [l/d] = 0.04 [m^3/d]

Daily Water Demand for Livestock on the Farm

DW_L [m^3/s] = ([$Mean_{dry(Wcalc.\text{-}spec.)}$* {x /100}]/[24*60*60]) – DW_P – DW_{IND}

$Mean_{dry(Wcalc.or\ spec.)}$ = Mean dry season water use (Wemp), mean of calculated and specified values in [m^3/d] (see Appendix II and Appendix IV)

x = Percentage of non-irrigation water use on farm [%] (interview specification).

If not specified in the interview, the sector’s median of 5% of mean dry season water use per day and farm dedicated to non-irrigation activities is used for the calculation.

Daily Water Demand for On-Farm Industrial Water

DW_{IND} = set at 0, according to interview specifications. Water used for industrial purposes is already included above in the percentage of non-irrigation water uses on the farm (see D_L).

The validity of both calculation procedures for mean dry season water use, W_{emp} and W_{dem}, are heavily dependent on the quality of the interview data. The first calculation procedure, W_{emp}, is completely based on interview specifications, and the second, W_{dem}, incorporates other values from the interviews, including the number of employees and the water used for purposes other than irrigation. Additionally, to obtain the values for river water abstractions per farm during dry season, water stemming from sources other than the rivers, such as storage water and groundwater, was subtracted from the mean dry season water use per farm. Hence, the data presented below on dry season river water abstraction requires careful interpretation, keeping in mind its basis in interview specifications. Due to the highly sensitive character of dry season water use and river water abstractions, interviewees might have underestimated their water use or given higher storage capacity. It was impossible to validate the interview data with measurements within the frame of the present study. Thus, the following results are the best estimates available, providing an order of magnitude for the dry season water use and river water abstractions of the commercial horticulture sector in the study area.

In most cases, the W_{dem}-data shows higher values than the calculated or specified figures (W_{emp}). There are various possible reasons for these variations. First, the *Demand Based Estimate* is a theoretical and general approach. For example, the irrigation efficiency is estimated to be 70%. However, most farms use drip irrigation and their irrigation efficiency is, according to interviews, at least 80% (if not higher), highlighting a discrepancy between the *Demand Based Estimate* farm level values and the reality. Second, this theoretical calculation approach is still very dependent on interview data, and there are several interview indications that might account for the differences:

- Mean dry season water use per farm and hectare could be higher than the values given during interviews, and thus the data has a diminishing effect on the specified or calculated values (W_{emp}).
- In reality, storage capacity and the duration of available stored water during dry seasons could be smaller or shorter, respectively, than indicated, and therefore would have an upward impact on the dry season river water abstraction values (W_{emp}).
- Dry season area under horticulture is one of the main inputs in the *Demand Based Estimate* equation. Hence, any inconsistency in those values would considerably influence the results of the calculation.
- Mean annual number of employees on the farm is another influencing factor on the *Demand Based Estimate* equation. However, it is much less critically determinant than the dry season area under cultivation.

Hence, one must question the accuracy of the data of the farms', and thus of the sector's, mean dry season water use to some extent, keeping in mind the restrictive dependency on interview data. However, the *Demand Based Estimate* tends to overestimate water quantities, as shown in Aeschbacher (2003, 69). He calculated river abstraction quantities on the Naro Moru River with the *AbstrCalcTool*, an abstraction calculation tool, and compared the results with values derived from the *Demand Based Estimate* method. He concluded that the values for most pipes and furrows were too high compared to the values garnered from the *AbstrCalcTool*. This is because the *Demand Based Estimate* neglects maximum transport capacity and disregards the dependence of river water abstractions by gravity (pipes or furrows) on river discharges. Thus, as Schuler proposed (2004, 111), one can assume that the W_{dem} values represent the maximum level of the mean dry season water use and the the W_{emp} values represent the minimum level of mean dry season water use, thus delimiting a frame of the real water use and water abstractions.

10.3. Dry Season Water Use of Commercial Horticulture

Commercial horticulture in the study area relies on year-round irrigation schemes. These water requirements create particular conflict with other water uses during the dry season, when water availability is low. Hence, the quantification of the sector's water use during dry seasons is important in order to assess the impact of the sector on dry season river water availability. The following section will thus focus on the current water requirements of the horticulture industry northwest of Mt. Kenya compared to the results from 2003. Figure 10.3 shows mean dry season water use of the commercial horticulture sector in 2013 compared to 2003, according to the two described calculation procedures W_{emp} and W_{dem}. They determine that water requirements of the total sector in the study area have increased by 209 l/s (W_{emp}) or 235 l/s (W_{dem}), respectively.

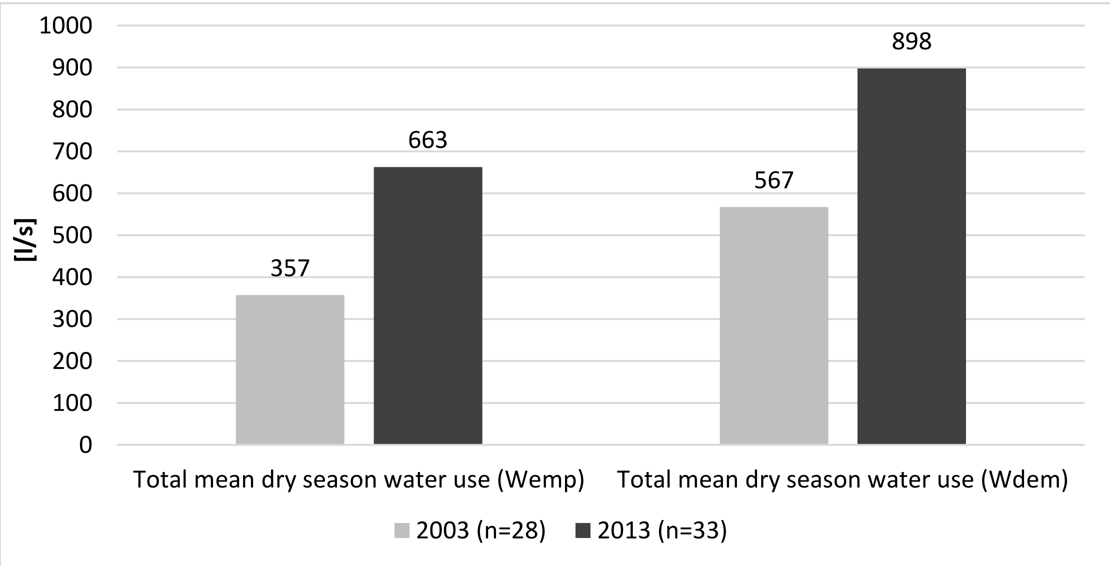

Figure 10.3: Total mean dry season water use (sector level) of the commercial horticulture sector NW of Mt. Kenya calculated according to two procedures (Source: Schuler 2004, 112; field survey 2013).

	W_{emp} 2003	W_{dem} 2003	W_{emp} 2013	W_{dem} 2013
Total sector's mean dry season water use [l/s]	457	567	663	898
Mean dry season water use **per farm** [l/s]	12.8	19.3	20.1	27.2
Mean dry season water use **per hectare** [l/s]	0.45	0.69	0.52	0.67

Table 10.2: Mean dry season water use of the total commercial horticulture sector NW of Mt. Kenya, per farm, and per hectare in 2003 and 2013 (Source: Schuler 2004, 112; field survey 2013).

This is unsurprising, as the number of farms has increased from 29 to 35. However, the mean dry season water demand per farm has also increased in 2013, as shown in Table 10.2. Meanwhile, the water use per hectare hardly changed from 2003 to 2013, as shown in Figure 10.4 (and Table 10.2). W_{dem}-values actually decreased very slightly from 0.69 l/s to 0.67 l/s. If these values were rounded to one decimal point, no variation would be visible. The small decrease for the W_{dem}-values is probably because W_{emp} values come from direct interview specifications on the water use per hectare and day. W_{dem} values, however, are calculated by dividing the total sector's dry season water use according to W_{dem} by the total dry season area under cultivation. Since the total area under dry season cultivation relies on calculations in cases where the interview indications were not precise enough, errors may be inherent. Appendix II and Appendix III provide detailed figures per farm and hectare.

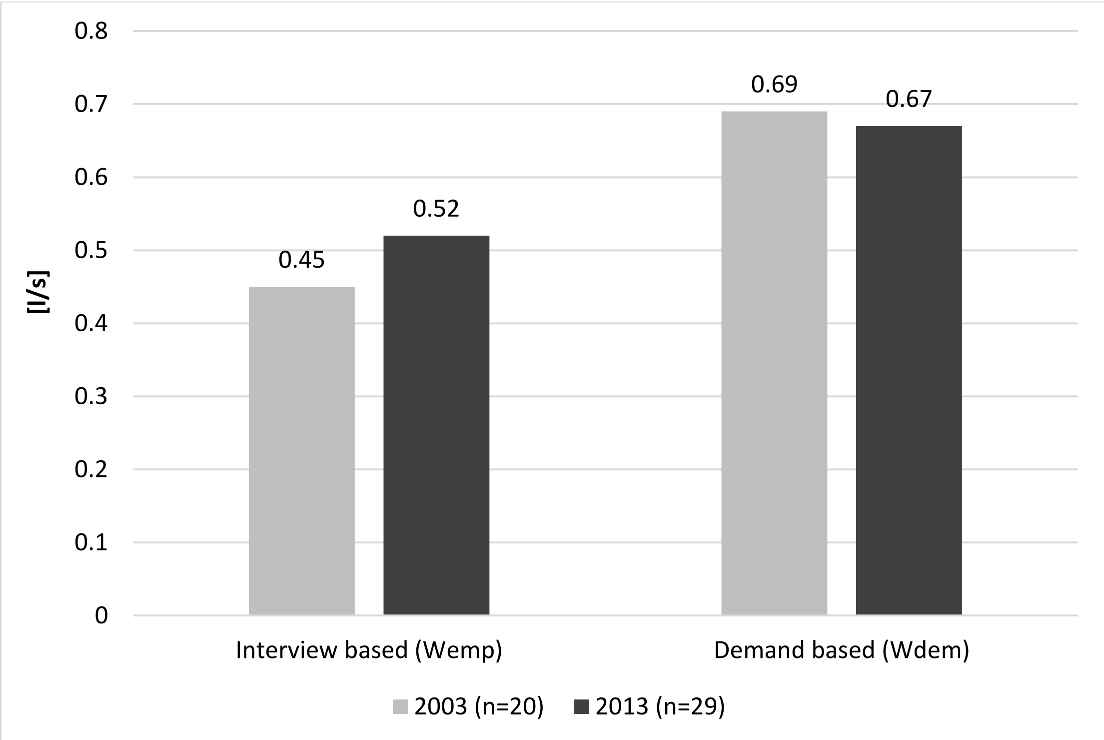

Figure 10.4: Mean dry season water use per hectare (W_{emp} and W_{dem}) NW of Mt. Kenya (Source: field survey 2003; field survey 2013).

10.3.1. Water Sources

The commercial horticulture sector on the northwestern slopes of Mt. Kenya covers its water requirements from three different water sources: river water, groundwater, and storage water. Storage water can either be rainwater harvested from the roofs of greenhouses, or floodwater from high river flows and surface runoff during the rainy season. Groundwater is always pumped through a borehole, which has a definite pumping capacity per hour. Many farms use a combination of various water sources (see Figure 10.5).[35] In 2003, most farms relied on a combination of river water and storage water (exclusively flood storage at that time, as rainwater harvest was not yet in practice). Groundwater was typically a supplementary source to bridge the dry season; only one farm named groundwater as its only source. The spread of usage of various water sources changed rather drastically in the past decade. As of 2013, only four farms rely solely on river water, while seven more use river water in combination with water storage. Most of these farms have self-regulating weirs on the rivers, which fill their dams during rainy season and cut off access to the river during the dry season. The storage water in this case is mostly harvested rainwater from roofs of greenhouses, thus indicating that these are flower farms, since vegetable farms rarely have greenhouses. There are also two farms, one producing flowers and the other producing herbs, that source their water exclusively from rainwater harvests. However, the number of farms relying on groundwater has strongly increased.

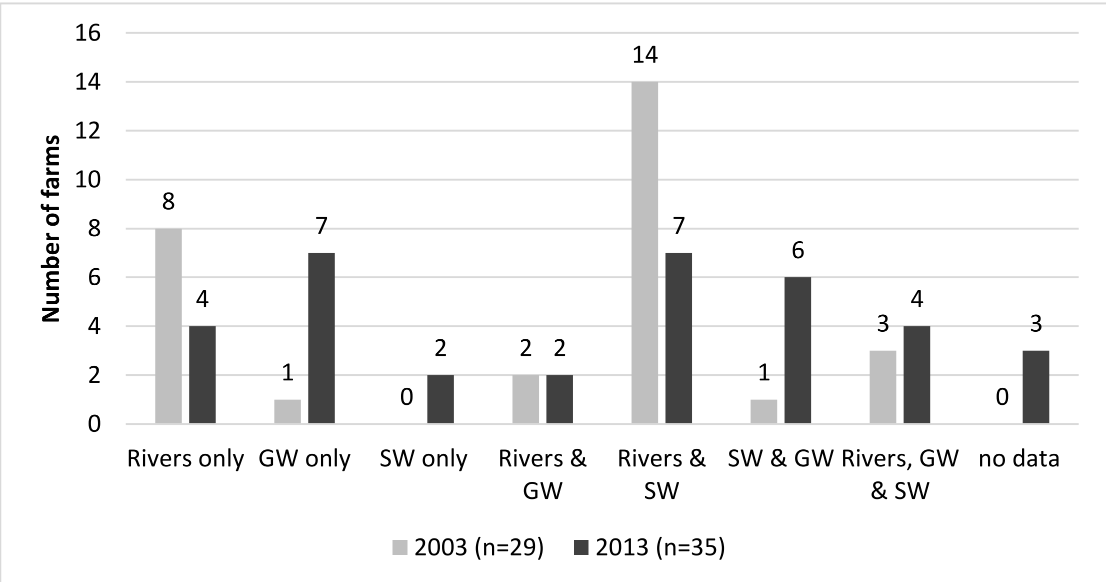

Figure 10.5: Water sources of the commercial horticulture sector NW of Mt. Kenya in 2003 and 2013 regardless of their relative importance. Legend: GW = groundwater, SW = storage water. (Source: field notes Schuler 2003; field survey 2013)

[35] Greenhouses used in floriculture are connected to one another; their rooftops are convex, but form a concave space at the 'gutter-connected' point of connection. Through a slight slope in the rooftops, rainwater accumulates in the concave spaces during rainfall and drains into the gutters, from where it is directed into a water storage facility, usually through PVC pipes. Thus, growers have the opportunity to collect large quantities of rainwater (up to 55% of their water requirements) that can be used for subsequent plant irrigation. (various interviews, e.g. E7, E8, E12, E17)

The dynamics between the aquifers and the rivers in the study area are largely unknown, and thus the impact of these many new boreholes to access groundwater cannot currently be analyzed. However, this is an important topic for further research. The Laikipia Wildlife Forum (LWF) is currently working together with the Mount Kenya Growers Group (MKGG) to assess further these interactions between aquifers and river repletion.

Water source	Wemp [l/s]			Wdem [l/s]		
	2003	2013	Increase 2003 – 2013	2003	2013	Increase 2003 – 2013
River Water	145	70	-75	349	277	-72
Storage Water	171	409	238	171	437	266
Groundwater	41	184	143	47	184	137

Table 10.3: Absolute contribution of various water sources in 2003 and 2013. (Source: Schuler 2004, 112-114; field survey 2013)

Thus, as of 2013, less farms rely on river water abstractions during the dry season, and instead source their water increasingly from groundwater and storage water. The absolute numbers further underline this trend (see Table 10.3): the dry season contribution from river water has decreased by 72-75 l/s, while contributions from storage water and groundwater have increased. Keeping in mind that water demand increased by between 209 l/s (W_{emp}) and 235 l/s (W_{dem}) in the past decade, one can see that the increased water demand comes primarily from storage water and groundwater. The significance of these changes becomes clearer in relative terms if we consult the percentage distribution between the different water sources as illustrated in Figure 10.6 (pies are sized proportionally). In 2003, 89-92% (depending on procedure of calculation, either W_{emp} or W_{dem}) of the farms relied on surface water for irrigation. However, 30-48% of this was in the form of water storage, which at the time consisted exclusively of floodwater from high river flows during the rainy season, and thus relieved pressure on rivers during the dry season. In 2003, groundwater constituted a rather small part of the water used; it registered a 12-17% increase to the year 2013. At the same time, river water use decreased by 29%, while storage water availability increased 14-17%. In sum, although water use during dry seasons increased for the sector as a whole, as well as per farm, dependence on river water resources has decreased in favor of storage water and groundwater, which have increased by approximately the same percentage. Detailed analysis on river water abstractions of the commercial horticulture sector follow in the next subchapter.[36]

[36] Calculation procedure as described in chapter 10.2.

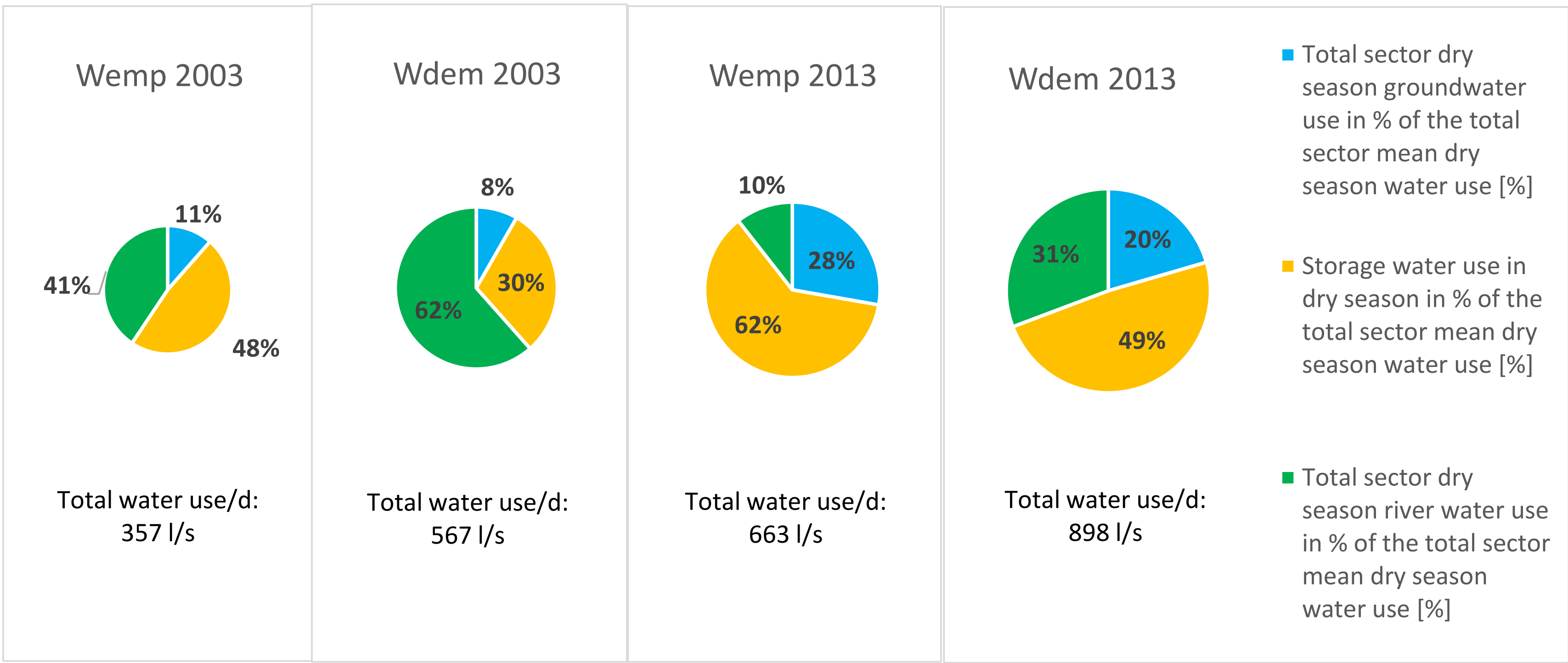

Figure 10.6: Share [%] of the different water sources (groundwater, storage water, river water) covering the total sector's dry season water demand in 2003 and 2013, according to the two calculation procedures W_{emp} and W_{dem}. Pies are proportionally-sized to the total dry season water use (Source: Schuler 2004, 114; field survey 2013)

10.3.2. River Water Abstraction by the Commercial Horticulture Sector

Although pressure on river water as a source of irrigation for commercial horticulture farms has decreased, the sector's impact on the dry season river low flow must be analyzed precisely. Although commercial horticulture farms may not source their water exclusively or even primarily from rivers, they remain a key component of water management. Various medium- and large-scale horticulture farms are located along different rivers in the study area. Figure 10.7 indicates the number of farms established along the ten river systems from which commercial horticulture farms source their water in 2003 and 2013. Figure 10.8 illustrates on how many hectares they cultivate crops during the dry season. It should be noted that the Ontulilli and Sirimon are two different rivers. In some of the 2003 interviews (C17 in 2003, E15 in 2013), the total intake quantity for both of these rivers was given together. Hence, although separate distribution percentages were given in 2013, in order to assure comparability to the 2003 data, the two rivers are treated as one in this analysis.

In 2003, the rivers Ngusishi and Sirimon/Ontulilli received the most pressure from the commercial horticulture sector in terms of the number of farms and dry season area under horticulture. Ten years later, in terms of the number of farms and dry season area under horticulture the rivers Teleswani, Burguret, and Ngusishi are the ones receiving most pressure from the commercial horticulture sector.

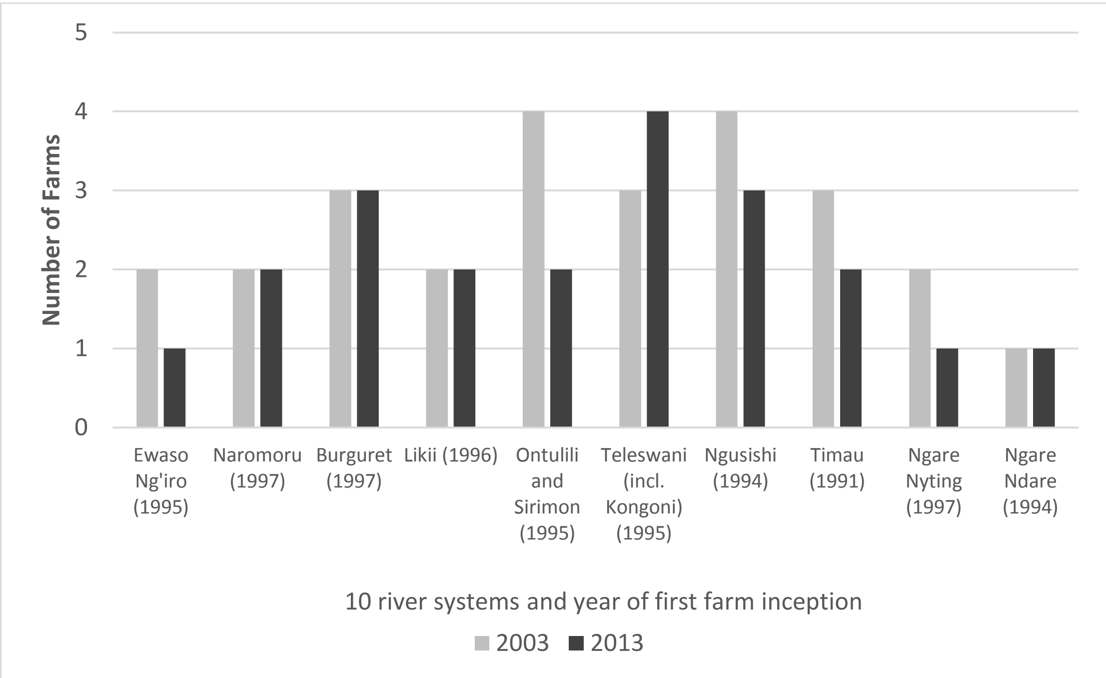

Figure 10.7: Number of Farms situated along the 10 river systems NW of Mt. Kenya in 2003 and 2013. Year of first farm inception along a specific river in parenthesis. (Source: Schuler 2004, 111; field survey 2013)

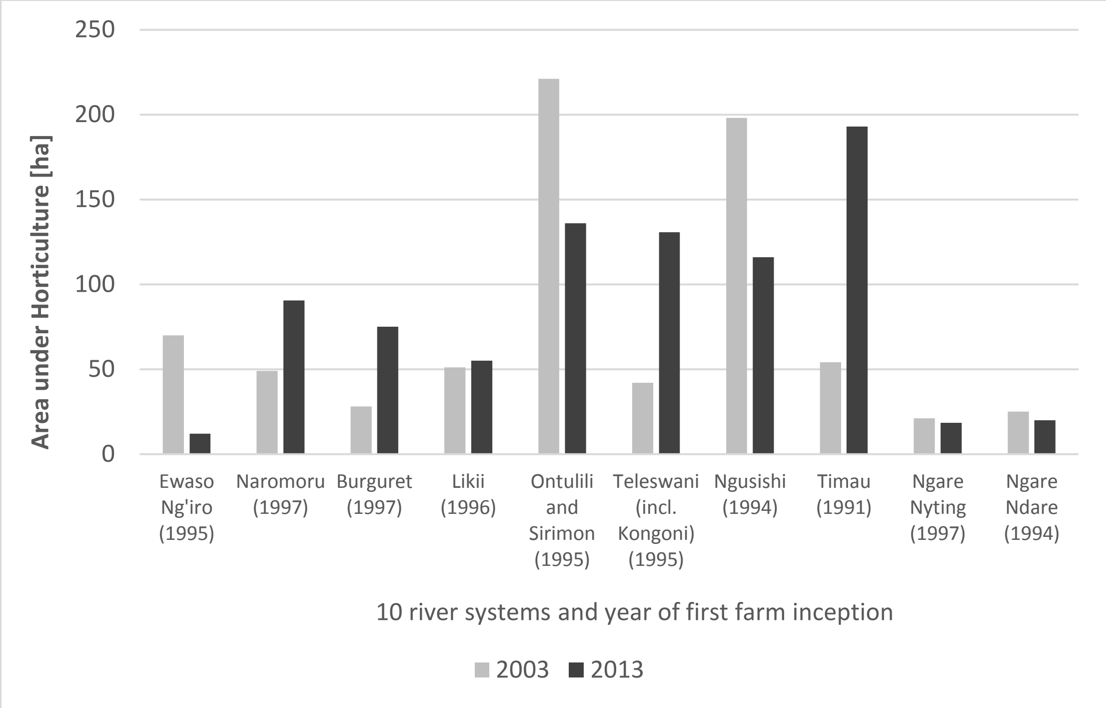

Figure 10.8: Area under horticulture along the 10 river systems NW of Mt. Kenya in 2003 and 2013. Year of first farm inception along a specific river in parenthesis. (Source: Schuler 2004, 111; field survey 2013).

Table 10.4 shows the absolute mean dry season water use of commercial horticulture farms sourcing part of their water requirements from the 10 river systems in 2003 and 2013 (W_{emp}; W_{dem}) (see also Appendix VI). The values here include possible groundwater and storage water availability; hence, they can be referred to as the potential pressure of medium- and large-scale horticulture farms on those rivers.

Name of River (Year of First Farm Inception)	**2003**		**2013**	
	Wemp	*Wdem*	*Wemp*	*Wdem*
Ewaso Ng'iro (1995)	16.8	46.7	2.8	8
Naromoru (1997)	40.6	33.8	35.3	60.6
Burguret (1997)	17.4	19.1	34.7	37.5
Likii (1996)	23	34.5	44	37.4
Ontulili and Sirimon (1995)	105.1	151.4	63.7	85.4
Teleswani incl. Kongoni (1995)	18.6	33	66.4	83.4
Ngushishi (1994)	82.6	144.5	51.2	101.4
Timau (1991)	31	36.9	130.4	130.8
Ngare Nyting (1997)	5.3	14.2	9.2	14.1
Ngare Ndare (1994)	9.7	17	10.4	13.8

Table 10.4: Mean dry season water use of commercial horticulture farms sourcing their water from the 10 river systems (= potential pressure on respective river from medium- and large-scale horticulture farms). (Source: Schuler 2004, 111; field survey 2013)

In 2003, the potential pressure on the rivers Ngusishi and Ontulili/Sirimon was highest. The river with the least potential pressure in 2003 was the Ngare Nyting. Ten years later, the pressure on Ontulili/Sirimon seems to have decreased in terms of the number of farms and area under dry season cultivation; the same is true for the Ngusishi River. These developments link to decreased activity around these rivers in terms of area under cultivation, as well as increased storage water availability and groundwater use. However, there are many more hectares under dry season cultivation along the Teleswani and Timau Rivers. The potential pressure on these rivers increased. Both increases in dry season water demand are due to the opening of new farms with a large number of hectares under cultivation along these rivers.

These values thus state the potential pressure of the farms in the study area on the various river systems. Nevertheless, the picture looks different if one analyzes the effective river water abstractions. This can be calculated by subtracting the available storage water and groundwater pumping (detailed in Appendix VI). Consulting these values, effective pressure on all river systems, except the Ngare Ndare River (W_{emp} and W_{dem}) and Naro Moru (only W_{dem}), has decreased since 2003. The reasons behind these decreases are an increase in available storage water and heightened reliance on groundwater.[37] On average, farms abstracted approximately 14.5 l/s (W_{emp}) or 32.5 l/s (W_{dem}) in 2003, compared to 3.5 l/s (W_{emp}) or 14.6 l/s (W_{dem}) in 2013. These figures help to convey the order of magnitude of the impact commercial horticulture had on river water in the study area. However, as we will see in the next section, the pressure that commercial horticulture exerted on the various rivers is distributed highly unevenly across the study area.

10.3.3. Dry Season River Flow Depletion

The present section integrates the problem of steadily depleting dry season river flows of the tributaries of the Ewaso Ng’iro River originating on Mount Kenya with the aspect of dry season river water abstractions of the commercial horticulture sector in the study area. The impact of medium- and large-scale horticulture on decreased low flows is analyzed between 1960 and 2012. In order to do so, flow duration curves (FDC) for selected rivers were generated. A flow duration curve (e.g. Figure 10.10) graphically depicts the percentage of time during which the flow at a specific river gauging station equals or exceeds the median. It is produced by plotting daily discharge data, ranked from highest to lowest, against the percent of days these flows were exceeded (rank divided by the number of data points). FDCs usually follow a logarithmic shape due to the typical behavior of rivers, where a few flood flows compensate long periods of below-average discharge. The 50% value represents the median river flow, which defines

[37] Groundwater use, however, might exert indirect pressure on the various river systems.

the level of discharge that the river equals or exceeds 50% of the time (Aeschbacher 2003, 94). February is the driest and hottest month of the year (Gichuki et al. 1998, 21); therefore, February flows are likely the most constraining in terms of water supply for the study area, and thus serve as a base reference for the evaluation of the horticulture sector's impact on dry season river flows. The flow duration curves are calculated based on February flows for the decades from 1961 to 1970, 1981 to 1990, 1993 to 2002, and 2003 to 2008/2012 for four tributaries of the Ewaso Ng'iro River in the study area. The median February flow from 1961 to 1970 represents natural conditions prior to human and commercial impact. The second period, from 1981 to 1990, covers the conditions just before commercial horticulture started in the study area. The decade from 1993 to 2002 is the period when medium- and large-scale farms started to establish themselves in the area, and the sector enjoyed its strongest growth. The final decade, from 2003 to 2012, represents the present state, with commercial horticulture firmly established in the study area and still growing moderately. The previously summed mean dry season river water abstractions of all horticulture farms along a specific river were then plotted in relation to the respective flow duration curves. In a final step (see Table 10.5), the differences between the median February flows of four pairs of decades are compared.

Flow duration analysis was not possible for the ten river systems that supply water to the commercial horticulture sector because some rivers lack the adequate series length of discharge data. Only those rivers with measurement periods dating back to the 1960s were included. The Sirimon River and Ontulili River were both excluded because their dry season river abstractions were inseparable. Additionally, the merge of the median February flow of those two rivers would have resulted in a rather rough approximation, and thus, consistent with Schuler's research in 2003 (Schuler 2004, 118), they were omitted. Finally, the river gauging stations had to be located below the commercial horticulture farms and their water intakes to assess properly the impact of the respective farms. Four rivers fulfilled all of these criteria, and flow duration charts were generated for them. The gauging stations are given in brackets.

- Naro Moru River (A5)
- Burguret river (A8)
- Teleswani River (AD)
- Timau River (AE)

Table 10.5 and Figure 10.9 show that the median February flows of the decade from 2003 to 2008/2012 are considerably lower than the natural median February flow of the decade from 1961 to 1970.

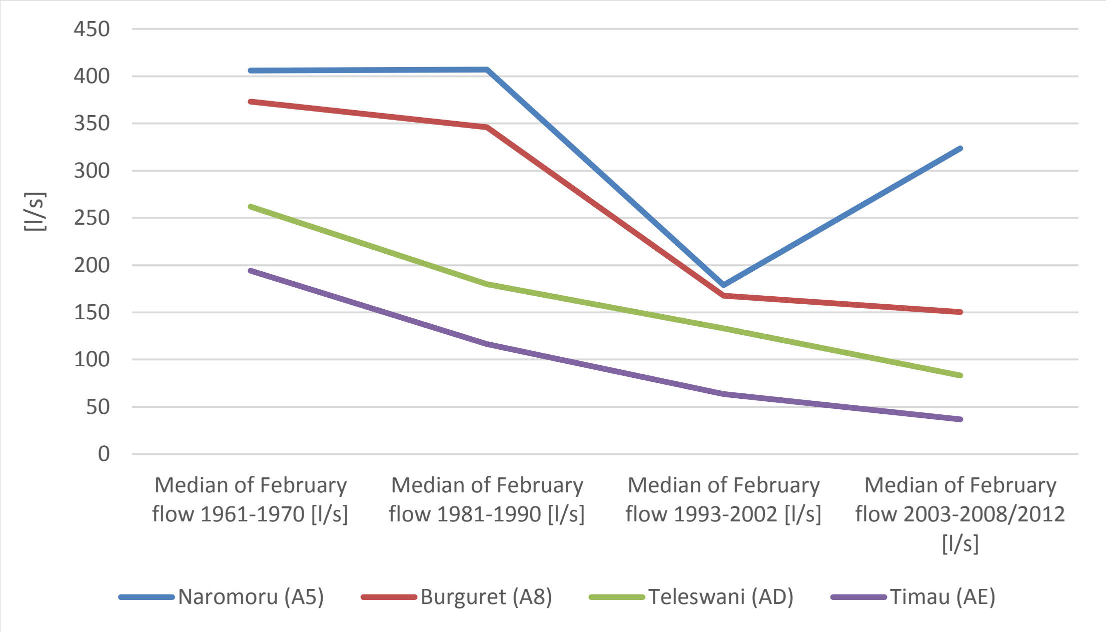

Figure 10.9: Medians of February flows of four different periods (1961-1970: assumed natural; 1981-1990: river flow before commercial horticulture started; 1993-2002: river flow while commercial horticulture developed; 2003-2008/2012: river flow while commercial horticulture developed) (source: Schuler 2004, 120; NRM3 database).

Name of River	Median of February Flow							
	1961-1970		1981-1990		1993-2002		2003-2008/2012	
	[l/s]	[%]	[l/s]	[%]	[l/s]	[%]	[l/s]	[%]
Naro Moru (A5)	406	100	407	+0.2	179	-56	324	-20.3
Burguret (A8)	373	100	346	-7.2	168	-55.1	150	-59.7
Teleswani (AD)	262	100	180	-31.3	133	-49.2	83	-68.2
Timau (AE)	194	100	116	-39.9	64	-67.2	37	-81.1

Table 10.5: Median February flows of the four rivers investigated during four 10-year periods and their percent decrease since the assumed natural state 1961-1970 (source: Schuler 2004, 119; NRM3 database).

Apart from the Naro Moru River, which shows a slight increase in median February flow from 1961-1970 to 1981-1990, all other rivers already register a decrease in the decade from 1981 to 1990. The decrease was especially high on Teleswani and Timau River with -31% and -40% respectively. This depletion of median February flows intensified further in the decades from 1981 to 1990 compared to 1993 to 2002, this time more strongly on Naro Moru (-56%) and Burguret (-48%). This encompasses the decade when Schuler conducted his research and the horticulture sector grew rapidly during its early stages. In sum, during that time, the Teleswani and Timau show a slowing decrease compared to the previous decade, while the Naro Moru and Burguret experienced an accelerated decrease rate during the period from 1993 to 2002.

In comparison, between the decades from 1993 to 2002 and from 2003 to 2008/2012, the Burgeret River stabilizes somewhat with a slight 5% decrease, while the Teleswani River and the Timau River still experience decreases in their median February flows by another 19% and 14%, respectively. Naro Moru River experiences a reverse development, with median February flow increasing by 36% compared to the previous decade. The reason behind this might be again climatic conditions; however, rainfall patterns were not significantly higher in that decade (Steiner 2014, 47–60). Other possible reasons are less pressure from commercial horticulture farms and other water users, as well as the establishment of a Water Resource User Association (WRUA). Considering continued abstractions, it is more likely that this increase is linked to the outdated calibration of the gauging station. A river's river cross-section can vary strongly. Since gauging station A5 on the Naro Moru was calibrated sometime at the beginning of the 1990s, and not again until 2012, the data in 2003 is likely based on an inaccurate calibration. Roger Nussbaumer (CDE, University of Bern) is currently writing his master thesis on an abstraction campaign on the Naro Moru River, and he confirms this assumption. Thus, three out of four rivers already experienced a decrease in median February flow before medium- and large-scale horticulture started in the study area. Those values, however, do not fully express the impact of the sector on river water depletion.

<table>
<tr><th colspan="3"></th><th>Naro Moru (A5)</th><th>Burguret (A8)</th><th>Teleswani (AD)</th><th>Timau (AE)</th></tr>
<tr><td colspan="3">Median of February flow [l/s] 1981-1990</td><td>407</td><td>346</td><td>180</td><td>226</td></tr>
<tr><td colspan="3">Median of February flow [l/s] 2003-2008/2012</td><td>324</td><td>150</td><td>83</td><td>37</td></tr>
<tr><td rowspan="2">Differences of median February flows of 81-90 and 03-08/12</td><td colspan="2">[l/s]</td><td>83</td><td>196</td><td>97</td><td>79</td></tr>
<tr><td colspan="2">[%]</td><td>-20.5</td><td>-56.6</td><td>-53.7</td><td>-68.6</td></tr>
<tr><td rowspan="4">2013 mean dry season water abstraction of commercial horticulture [l/s] and their contribution to median February river flow depletion [%]</td><td rowspan="2">[l/s]</td><td>Wemp</td><td>2.6</td><td>9.9</td><td>6.2</td><td>1.7</td></tr>
<tr><td>Wdem</td><td>27.9</td><td>24.4</td><td>22.3</td><td>5.2</td></tr>
<tr><td rowspan="2">[%]</td><td>Wemp</td><td>3.08</td><td>5.03</td><td>6.41</td><td>2.18</td></tr>
<tr><td>Wdem</td><td>33.41</td><td>12.47</td><td>23.06</td><td>6.51</td></tr>
</table>

Table 10.6: The contribution of commercial horticulture dry season river water abstraction from the respective river to the differences in median February flows between 1981-90 and 2003-2008/2012 (Sources: Schuler 2004, 122; NRM database; field survey 2013).

In order to evaluate the impact of commercial horticulture on the depletion of the median February low flow of the various decades, the mean dry season river water abstractions of the sector are calculated in relation to the differences in the median February flow values of the four rivers (see Appendix II and Appendix III for detailed calculations).

Until 1991, there was no commercial horticulture in the study area, and therefore the difference between the period from 1981 to 1990 and 2003 to 2008/2012 is taken as a reference value for the evaluation of the impact of the sector. Two different percentages of the impact of commercial horticulture on median February river flow depletion are provided for each river, due to the two different calculation procedures W_{emp} and W_{dem}. Table 10.6 gives the absolute and relative values of the contribution of commercial horticulture dry season abstraction from each respective river to the differences of the median February flows between 1981 and 1990 and 2003 and 2008/2012. Below, each river is discussed individually in their respective flow duration chart.

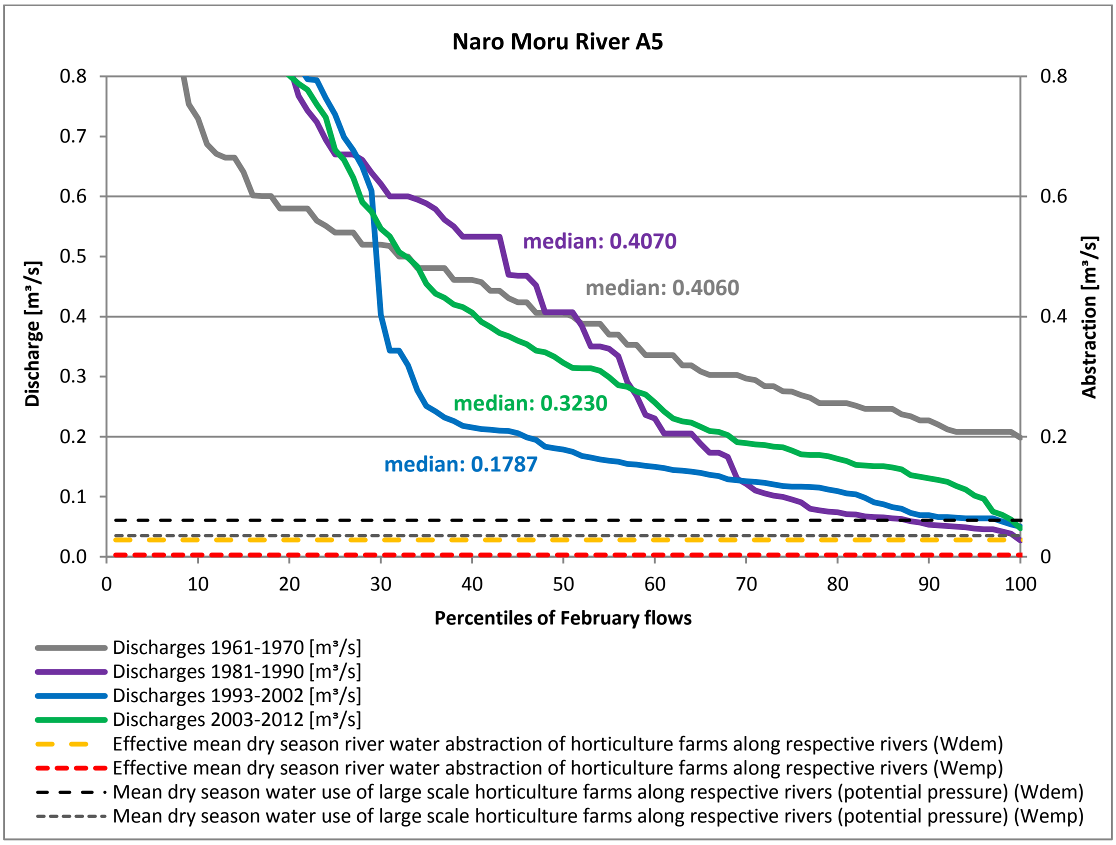

Figure 10.10: Naro Moru river (A5): February flow duration curves of four different decades and mean dry season water abstractions of riparian horticulture farms (W_{emp} and W_{dem}) as well as simulation of river water abstractions if there were no water storage or groundwater access. (Source: Schuler 2004, 121; NRM3 database; field survey 2013)

The contribution of commercial horticulture to the depletion of the median February flows between 1981 and 1990 compared to 2003 to 2012 on the Naro Moru River is 3.08% (W_{emp}) or 33.42% (W_{dem}). In terms of *Demand Based Estimate* values, the Naro Moru River registers the highest absolute dry season river water abstraction from commercial horticulture farms. The flow duration chart (see Figure 10.10) shows that, though the median remained stable between 1961 and 1970 and 1981 and 1990, the 1981 to 1990 graph drops strongly afterwards compared to the 1961 to 1970 graph. However, river low flow seems to have recuperated since 2003.

Considering continued abstractions, it is more likely that this increase is linked to the outdated calibration of the gauging station as discussed previously. Therefore, the data from 2003 is not reliable and does not allow for comparison between Schuler's work and the current study. By ignoring storage capacities and groundwater access, the mean dry season water use of all the farms sourcing water from Naro Moru simulate the potential pressure on the river (black and grey dotted lines), which would be much higher. Hence, this underlines the importance of storage water for commercial horticulture during dry season.

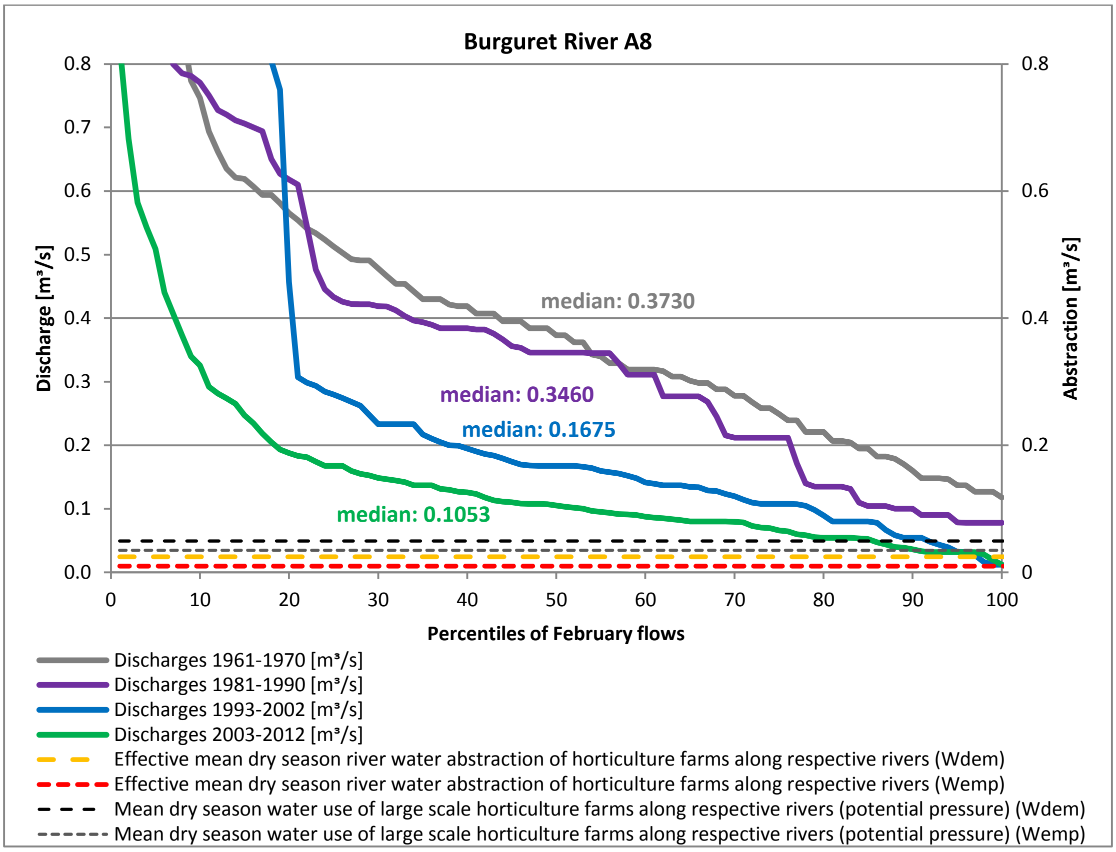

Figure 10.11: Burguret river (A8): February flow duration curves of four different decades and mean dry season water abstractions of riparian horticulture farms (W_{emp} and W_{dem}) as well as simulation of river water abstractions if there were no water storage or groundwater access. (Source: Schuler 2004, 122; NRM3 database; field survey 2013)

The contribution of commercial horticulture to the depletion of the median February flows from 1981 to 1990 and 2003 to 2012 on the Burguret River is 5.03% (W_{emp}) or 12.47% (W_{dem}). In 2003, the absolute mean dry season river water abstractions on the Burguret River were negative values, which are implausible, as they suggest that the farm contributes to river recharge. According to Schuler (2004, 131) "[t]hese negative values are presumably induced by inconsistencies in the interview data on the floodwater storage capacities of the riparian farms." Thus, the current abstractions cannot be compared to 2003, and there is no way to determine if pressure on the Burguret River from commercial horticulture has increased between the decades from 1993 to 2002 and 2003 to 2012. Figure 10.11 shows the constant decrease of the median February flow of the river since its assumed natural state in 1961 to 1970. Assuming there was no water storage or groundwater access, the mean dry season water use of all the farms sourcing water from Burguret simulate the potential pressure on the river (black and grey dotted lines), which would mean that approximately 10% of the time water demand exceeds water availability. There are currently three medium- and large-scale horticulture farms along the Burguret River. One of these farms does not rely on river water at all, as it has a water dam, really a small lake, at its disposal that fills with harvested rainwater from the roofs of greenhouses. The second farm also has floodwater storage, which is used in combination with river water during the dry season. The third farm, although it is small and operates on just four hectares, relies heavily on the river and practices flood irrigation that prompts heavy water use. The intersection between river low flow in the period from 2003 to 2012 and the river water abstractions is at about 98% (W_{dem}) or 99% (W_{emp}); hence, during 1-2% of the time in February, demand is higher than availability.

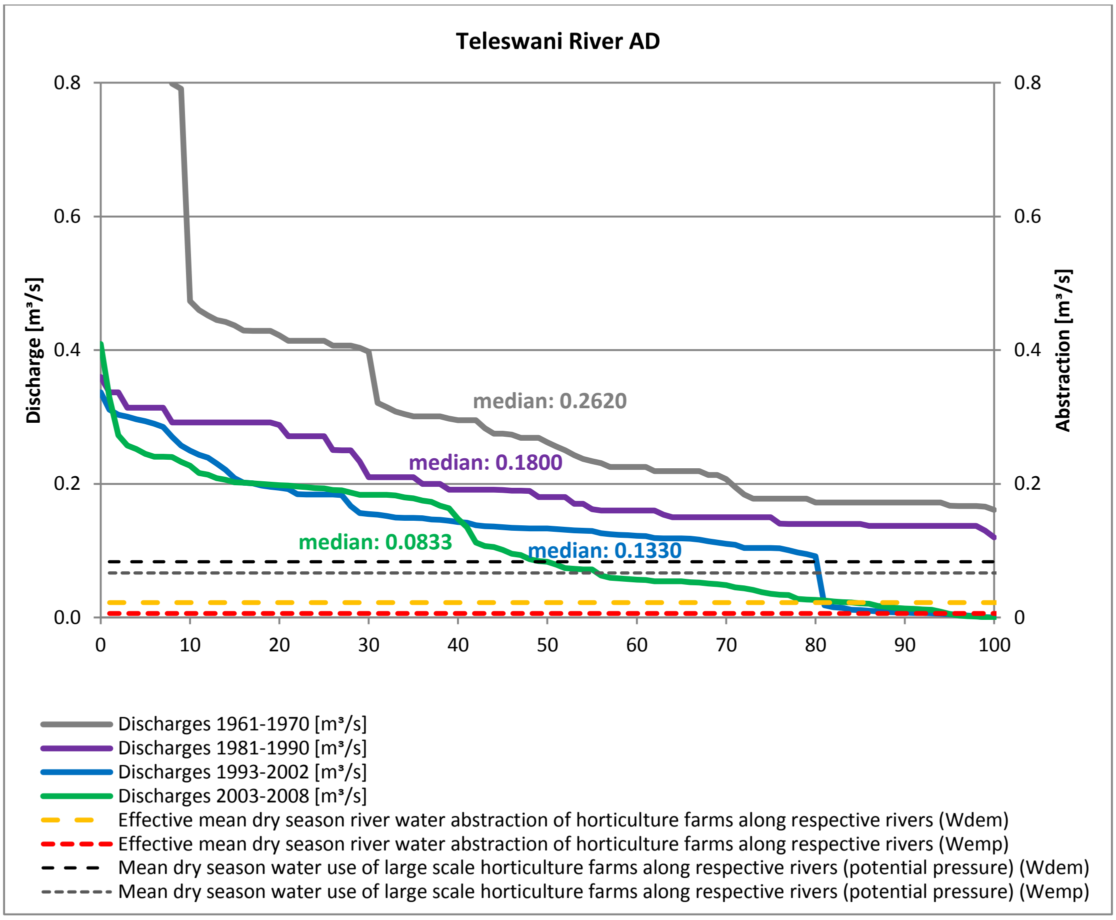

Figure 10.12: Teleswani river (AD): February flow duration curves of four different decades and mean dry season water abstractions of riparian horticulture farms (W_{emp} and W_{dem}) as well as simulation of river water abstractions if there were no water storage or groundwater access. (Source: Schuler 2004, 123; NRM3 database; field survey 2013).

The contribution of commercial horticulture to the depletion of the median February flows from 1981 to 1990 compared to 2003 to 2008 on the Teleswani River is 6.41% (W_{emp}) or 23.6% (W_{dem}). The simulation with no water storage and no groundwater access shows that the contribution of the commercial horticulture farms to the depletion of the median February river flow would be much higher (black and grey dotted lines), namely, 68.67% (W_{emp}) or 86.25% (W_{dem}). If there were no alternative water sources on these farms, there water abstractions would exceed the median February river flow approximately 50% of the month of February. In 2003, commercial horticulture showed the largest impact on the declining February river flows of the Teleswani River. The three riparian farms existing then had no water storage. Today, two of those farms still exist while the third closed down, and a new one opened in 2013. Of the two farms that persisted, one (E4) installed a floodwater storage facility, which more than covers the farm's dry season water demand. Hence, pressure has decreased from this particular farm. However, water demand at the two other horticulture farms is still mostly dependent on the river during the dry season, even though one of the farms has a borehole. Still, considering Figure 10.12, one can see the rapid depletion of the Teleswani River in the past two decades. River water abstractions based on the W_{dem} calculation procedure are higher than the February river low flow 80% of the time; river water abstractions based on the W_{emp} are higher than the February river low flow 90% of the time. This means, that abstractions are higher than the median February river flow approximately 10-20% of the month of February. Hence, even though there is new water storage lessening the pressure on the river, the Teleswani River has particularly low values of median February flows and is thus very sensitive to further pressures, such as water abstractions.

On the Timau River, the contribution of commercial horticulture to the depletion of the median February flows from 1981 to 1990 compared to 2003 to 2008 is 2.81% (W_{emp}) or 6.51% (W_{dem}). These are the lowest values in both relative and absolute terms (see Table 10.6) for the contribution of commercial horticulture to river flow depletion among the four rivers studied. Both farms along the Timau River have large water storage capacities that cover their dry season water requirements. Since 2003 the absolute values of dry season river water abstractions have slightly increased (see Table 10.6), in relative terms, abstractions from commercial horticulture have had less impact in the past decade than during the first decade of horticultural activity in the study area. Again, the simulation with no water storage and no groundwater availability shows that the contribution of the commercial horticulture farms would be much higher, namely intersecting at roughly 5% percentiles of February flows; hence, during 95% of the time in February, demand would be higher than availability. This strongly underlines the importance of water storage facilities for the commercial horticulture sector in the study area. However, the effective intersection between river water abstractions and February low flows is about 88% (see Figure 10.13) for both W_{emp} and W_{dem}, meaning that commercial horticulture's water demand along the Timau River exceeds water availability during roughly 12% of the month of February.

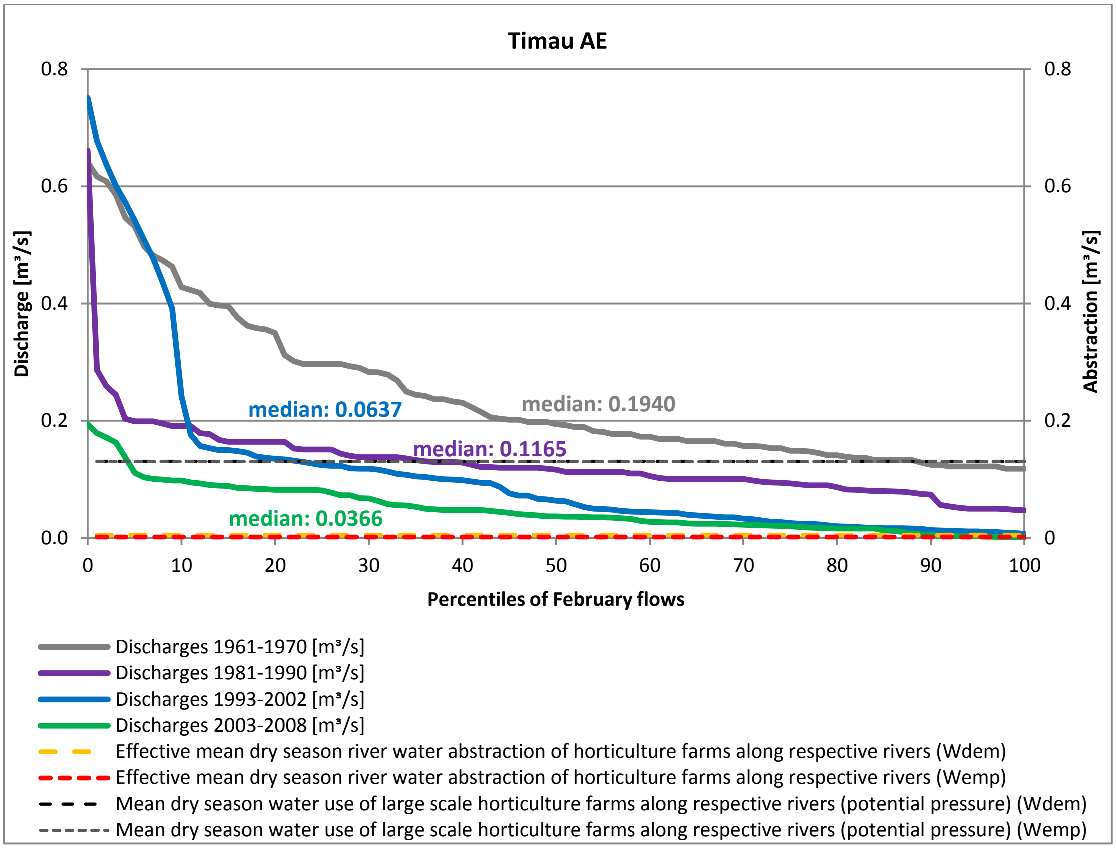

Figure 10.13:Timau river (AE): February flow duration curves of four different decades and mean dry season water abstractions of riparian horticulture farms (W_{emp} and W_{dem}) as well as simulation of river water abstractions if there were no water storage or groundwater access. (Source: Schuler 2004, 124; NRM3 database; field survey 2013).

Figure 10.14 summarizes the findings of the above analysis. The bluish columns on left side show the respective river's median February flow depletion. It is thus evident that for all rivers except the Naro Moru, median February flows already started to deplete prior to the establishment of commercial horticulture in the study area. The orange columns on the right side show effective river water abstraction during dry seasons. The negative values (shown as zero) for the Burguret River are attributed to inconsistencies in the interview data on the floodwater storage capacities of the riparian farms (Schuler 2004, 131). The purplish columns show dry season water use of commercial horticulture without taking water storage or groundwater use into account, and hence, the potential pressure on the sector. This shows the tremendous influence of water storage and groundwater availability to mitigate pressure on rivers during the dry season. This does not apply to the Teleswani River in 2003, as all dry season water requirements were fulfilled by the river at this time, with no other water sources in use. Without storage and groundwater, commercial horticulture on the Timau River would be impossible, and the situation would be critical on the Teleswani River. The figures show the median February flow of the respective decade, and thus, variations within the decade as shown in the FDCs are not visible in these figures.

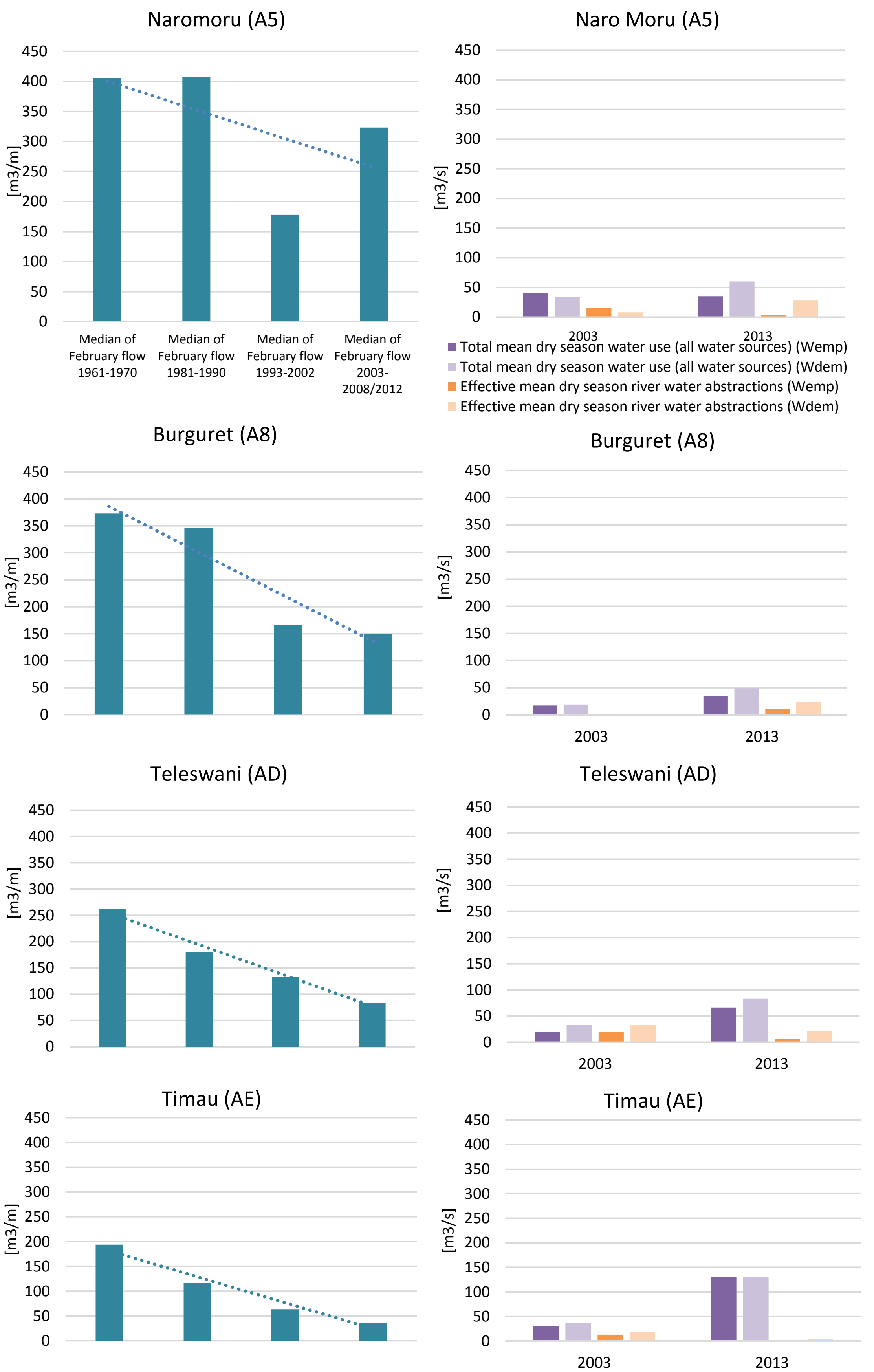

Figure 10.14: Overview over depleted median February flows of the periods 1961-1970, 1981-1990, 1993-2002 and 2003-2008/2012 (left) of the four rivers investigated and the horticulture farms' dry season water use (purple) and abstractions (orange) (source: NRM 3 database; Schuler 2004, 125; field survey 2013).

Water storage capacity and groundwater availability are important to lessen pressure on rivers during dry season and ensure continued production. Figure 10.14 shows that commercial horticulture would, for example, require three times the available low flows along Timau River; along Teleswani River, it would use all the river water available. From the farms that existed in both 2003 and 2013, all but one (E26) invested in maintaining or increasing their storage capacity. However, this may have been accompanied by an increase in area under cultivation, which is a crucial factor in understanding the sufficiency of water storage.

Appendix VII provides a detailed list of the water storage capacities, daily borehole yield, and area under horticulture per farm according to today's inventory. If the farm existed in 2003, the same data is also given in that year to allow for comparison. Of the 19 new farms that opened in the study area since the beginning of 2003, two farms have neither boreholes nor water storage capacity, four farms have one or several boreholes, another four farms have water storage capacity, and seven farms have a water storage facility and one or several boreholes. Details on which farms use each water source, and to what degree, can be found in Appendix IV.

This approach gives an order of magnitude for the impact of commercial horticulture on river water depletion during the dry season for the period from 2003 to 2008/2012. However, it does not reveal details on single years with extreme occurrences, such as droughts, and thus these events will not be discussed. The data does reveal that water storage is of the utmost importance, not only for horticulturists to ensure production, but also for potential situations of conflict with other water users, as will be discussed in the following subsection.

Photo 10.1: Greenhouses on E7 wih PVC pipes that drain the rain water harvested in the concave space between roofs into a water storage facility (NL).

10.4. Awareness of Water-Related Conflicts and Mitigating Strategies

As median February river flows deplete, diminished water availability becomes an increasingly large constraint for horticulture farmers who need to switch to alternative water sources in order to continue their production. In 2003, water availability was the major constraint for the future development of the sector. Many farms now operate with storage water and/or groundwater to either substitute river water completely or bridge low river flows during the dry season. However, the sector still has an impact on dry season river water flows, especially if on-farm water storage capacities are limited or absent. Furthermore, as highlighted in the introduction (see chapter 1), various explicit and latent conflicts over scarce water resources occur in the Upper Ewaso Ng'iro North River Basin. For these reasons, the opinions and impressions of the actor-category of commercial horticulturists in the study area on river water availability and water-related conflicts are of great interest, as well as their strategies to reduce pressure on rivers and mitigate conflicts.

Water is, for most horticulturists, perceived and understood as being a source of conflict, since rivers cannot support all the users and their requirements during the dry season. Approximately 25% of farmers indicated that they did not see any conflict potential around water in relation to their medium- and large-scale horticulture activities.[38] Two of these, however, saw no conflict because they have their own water storage facilities and do not use any river water (E6, E17). All of the other farmers are aware of potential conflicts arising from water use, especially during dry seasons. The problems, according to horticulturists, result from excessive and illegal abstractions and poor management; when water is short, the issue arises of how to divide the water between community pipelines, medium- and large-scale horticulture, smallholder horticulture, and any local, growing towns. Most often, people upstream receive the blame for limited access to river water during dry seasons, but frequently, commercial horticulture farms are also held responsible for depleted river flows, weather justified or not (various interviews, e.g. E1, E5, E12, E14, E23), as these quotes highlight:

> "[…] people downstream will always think that people upstream are taking all the water and leaving them with nothing. This has been a big issue. And especially when people look at a big company like us. They will think: this is the thief. I remember one time with my borehole, and pumping water from the borehole to the dam, the guys would come and say: E27 is stealing all the water; you see it's going into the dam. […]" (Interview E27)

> "Water is a very contentious issue. We try and manage it as best as we can, but obviously because we are a big corporate user, there is a general perception that we abuse water, which we don't. But we obviously belong to all the water user associations, we attend all the meetings, and we try to be as helpful as we can. We have never had a

[38] E6, E8, E10, E13, E17, E19, E21, E28

> serious conflict around water. But I do believe it can become an issue very quickly. Not just here, in Kenya in general." (Interview E15)

These conflict potentials, coupled with various newspaper articles (see chapter 3.4) demonizing commercial horticulture and its water use during the dry season, have led to political pressure on commercial farms that, in turn, initiates conflict-mitigating strategies. Three different strategies to mitigate conflicts are pursued by the various commercial farms: (1) River Water User Associations, (2) technical strategies, and (3) adapted irrigation practices.

In 2002, the Kenyan government adopted a new water act that was subsequently operationalized in 2005. The 2002 Water Act made Water Resources Users Associations (WRUAs) mandatory to drive community participation in water resource management activities (WRMA 2013). The formation and establishment of these WRUAs played an important role in conflict mitigation (various interviews, e.g. E4, E11, E14, E25), as the following quote underlines:

> "[…] in the past there definitely were [conflicts]: there would be sort of physical encounters, where one group would come and destroy intakes of another. But that was sort of prior to Water User Associations being formed. You know, post Water User Associations all conflicts are being resolved by the association and within the association. And conflict resolution is done by rationing and that sort of thing and making sure everybody has a fair access to water." (Interview E16)

As WRUAs are now mandatory, every farm holds membership in at least one WRUA, even if they do not use any river water. Some are members of more than one association, as they source water from various rivers (e.g. E15). Currently, medium- and large-scale horticulture farms are members of fifteen different Water Resource User Associations. The interview with former horticulturist E31 shed some interesting light on the formation of the WRUA Ngusishi, one of the first associations in Kenya and one that receives praise for its stellar management and implementation. E31, together with another horticulturist who is still in the business (E11) and other community leaders started the WRUA Ngusishi in 1998. Thus, they pioneered the process by initiating the WRUA before it became mandatory. However, according to interview E31, the first eight years establishing and raising the WRUA were "[…] an absolute nightmare." He described the underlying water conflicts and the beginning of the WRUA, and why these associations are so important, very impressively and illustratively:

> "The first thing that Africa will fight over is water. You know, most of the world fights over religion, but here in Africa it's going to be water. There is a lot of conflict over the river during dry season. People from downstream would come up until where they found the water and where everyone was flood irrigating and would just break pipes. And you would have 60 people coming through with machetes and djembes and invariably some would be high, and some would be drunk and it was a very unstable situation. It never affected us because we always followed the rules but I saw them often during the dry season. And the rivers that run 24 hours of every day of every year now would be completely dry during the month of January, February and March until the rains arrived and again in September, October until the rains arrived they would be

> completely dry. So nobody was getting drinking water down below. And when we set up the association, the biggest problem was one word and it was TRUST. Because it was dog-eat-dog, everyone was saying: *'they're stealing, they're stealing.'* And we had a couple of guys who were politically motivated and one guy blocked the association for eight years. Eventually, we [E11 and E31] put in a weir, and put in a common intake. It's a self-regulating weir, so the only guy who regulates it is *Mungu* [God]. So, if there is a lot of rain, everyone gets lots of water, if its dry, everyone's water use gets reduced, but it's even. […].Water is, you know, if you look at the five requirements of a human being, water is one of them. It's hugely important. […] we put the weir in; there was a huge amount of skepticism, as to how it would work. And the minute the water flowed over, and everyone understand [sic!] how it worked, the whole association came together. And we now have a system where there is no fighting, there is no aggression, there is no malice, there is no sabotage of other people's property, there is a sense of ownership, there is an obligation that water is not free, everybody pays for it, everyone's water is metered. […] and every month, if the water is not paid for, that project is disconnected. It [the Ngusishi Water Resource User Association] is the leading water association in Kenya. […]The fact that it is a small river has probably meant that we could bring it to work that much quicker. […] So we've got two of us who are on the board from the medium- and large-scale farms and two community guys. And they're the face of the association. It made the community that much stronger. If you came here six years ago, we would have said that the most stressful thing in our life is the water meetings. Because we would go to the water meetings, we'd need to have government officials, police officers and the chiefs there and 8 times out of 10 the meetings would have to have been disbanded before concluded because of it turning violent. It was a serious problem. And the amount of time that I had to put in, you know, where you just sit in the middle of the hot sun and, you know, if you stand up in this area, people fight, if you sit down, people listen, and we would sit in the sun for hours and hours and hours and hours, hours until everyone had no strength left in their lungs. And we would go around and around and around. And it was one thing, TRUST, which we now have. So problems happen and issues arise but no one gets upset. You deal with the issue and everyone works around it. And if the model that we have can be spread across the region, you could go to the bottom of the Ewaso Ng'iro and you will see water there every day of every month of every year, which you don't at the moment." (Interview E31)

This rather long quote illustrates the many-layered problems behind water conflicts. There are political and economic considerations, but often water is a very emotional issue as well. Thus, Water Resource User Associations are an important tool to regulate water use and manage the resource adequately and justly to prevent attempts for personal and political advancement or emotionally laden conflicts. Many medium- and large-scale farms sit on WRUA committees in order to cooperate with surrounding communities and discuss effective or perceived injustices directly before conflicts have a chance to escalate.[39]

Another important and very effective mitigating strategy is technical solutions, like water storage facilities. Water storage, as well as the use of groundwater as an alternative water source to rivers, helps lessen the pressure on rivers during the dry season. Farms that operate completely without river water during dry seasons or throughout the year report that they have no water

[39] E7, E11, E14, E16, E22, E23, E25

issues with surrounding communities (e.g. E6, E7, E17). Thus, sufficient water storage, especially when it is harvested from rainwater, grants the commercial horticulturist a certain security from time- and finance-consuming conflicts with surrounding communities, as well as valuable independence from rivers. Horticulture, and especially floriculture, is a capital-intensive business, and therefore, independence from river flows is a great asset to guarantee production regardless of weather conditions and river flows. Of the 35 farms operating in the study area, 18 have substantial water storage facilities, and 9 of these 18 additionally have a borehole to access groundwater. Another 9 have boreholes, but no water storage. This means that at least 27 of 35 farms have additional water sources beyond river water, as there is no data for three of the farms. This variety of available water resources allows commercial horticulturists to adapt their strategy as needed, as interviewee E27 explains in the following quote:

> "So what I generally do in January, February, is I take out my valve from the river. So nobody is going to argue that I'm even taking in water. I just use what we have stored." (Interview E27)

As we saw in chapter 10.3.1, groundwater has only become important as a water source in recent years. It is unclear what the interactions between the various rivers and the tapped aquifers are, but the digging of many boreholes in recent years and may very well become problematic for river replenishment in the future. Thus, it cannot be assessed if groundwater use is indeed a positive and viable alternative to river water use: while it helps to offset current shortages during dry seasons, its long-term effects must be further assessed. Another measure that has become increasingly important, according to various horticulturists, is the adjustment of irrigation practices. Many farms have electronically monitored and regulated drip irrigation technologies, which calculate the precise amount of water needed per single crop plant and administer it very efficiently (almost all flower farms, e.g. E5, E8, E10, E16). Figure 10.15 shows that 77.6% of the farms in the study area apply drip irrigation, while only 5.7% and 5.3% use the alternative technologies of overhead irrigation and floodwater irrigation, respectively.

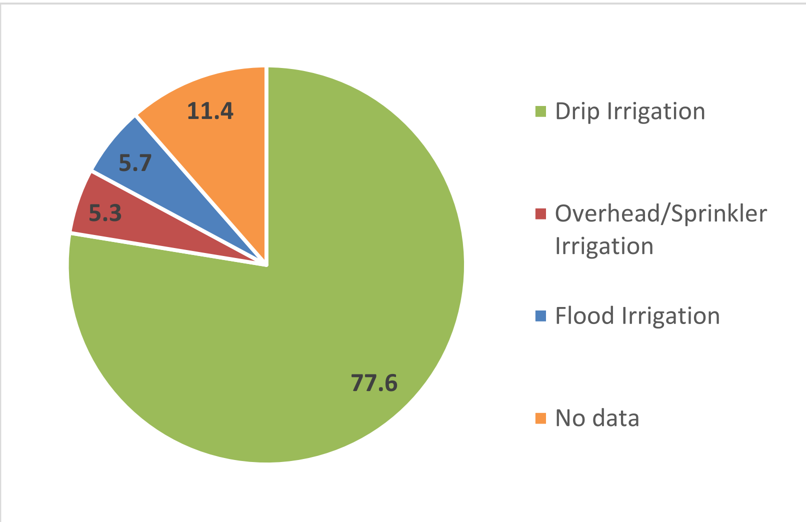

Figure 10.15: Share [%] of irrigation technologies used by commercial horticulture farms NW of Mt. Kenya in 2003 (Source: field survey 2013).

The 5.3% using floodwater irrigation had the infrastructure from drip irrigation, but it was broken at the time of the farm visit due to poor maintenance. This prompted the restoration to flood irrigation, which does not require specific infrastructure but is the less efficient irrigation technology. However, the high percentages of farms applying solely drip irrigation, some of it computerized, means that most farms have highly efficient irrigation systems, and thus experience very little water loss through evapotranspiration or leaks.

Photo 10.2: Water storage facility on E6 (NL)

An additional strategy to mitigate conflicts, especially for farms located within a community, is the transmission of skills and trickle-down effects. Again, interviewee E31 formulates nicely how horticulture farms are aiming to go beyond the mandate of the WRUAs:

> "The general concept of the mandate of the government is that we get 70% allocation for our projects [projects designate water amount that goes to the various users] and we have to guarantee that 30 % gets into the next river. So then you take that concept and you say '*we've achieved the primary goals, so now what are the goals*?' The goals then become *'how do we improve that standard of farming?'* We have now various drip kit demonstration sites. So how it works is, you go to the best farmer and you get him to take it on board and everyone sees that he has more cows and a better house and a better this and that. The knock-on effect is that they want the same, so that's happening. Again, there is a program for roof harvesting, supporting HIV families, etc. You know, the model of the water association is tiny, but the effect is huge. It relates to the problem of hygiene: lots of people have long drops, they are working now to get those away from the river and also installing sceptic tanks. So the knock-on effect is in every direction, from farming practices, to hygiene, to getting kids to go to a better school: it's just win-win-win. […]." (Interview E31)

In addition to these conflict-mitigating strategies, the general shift from vegetable production to floriculture has brought with it a reduction of pressure on river water resources. This has three reasons: first, flower production is more or less constant throughout the year; especially high quality roses produced in the study area are in demand year-round, with highs on Valentine's Day, Mother's Day, the summer wedding season, and Christmas. These peaks are mostly short times and do not exclusively coincide with the study area's dry season. In contrast, vegetable production depends greatly on the European season at the time, with highs coinciding with the region's dry season. Thus, the shift from vegetables to flowers accounts for some lessened pressure on rivers. Second, flowers are grown in greenhouses and thus water is administrated through drip irrigation that is often computerized and leads to minimal loss. Finally, greenhouses are constructed so that they can gather rainwater in specially designed grooves in the roof, from which water slushes down into pipes and collects in a water storage facility. Hence, if this system is modernized and infrastructure is maintained, it can provide the majority of the water requirements of a farm.

Thus, these considerations make clear that water security is a very important issue for commercial horticulture in the study area. It is no longer the most significant problem, as it was in 2003, because of the various strategies undertaken as well as the local production shift toward flowers. However, failure in the application and implementation of these measures can instantly make the situation as precarious as it was ten years ago. Water availability is not only a source of life for people living in downstream locations, but is also necessary to guarantee the economic survival of commercial horticulture northwest of Mt. Kenya.

10.5. Water Quality

One of the research questions for this chapter was around the importance of water quality in the commercial horticulture sector's impact on river water resources. More precisely, this requires an investigation of how the use of fertilizer and chemicals by medium- and large-scale horticulture farms in the study area affects water quality. Only one company (E12) answered this question conclusively, while all others refused to answer or made general, inconclusive statements. This was sometimes due to interviewee discomfort, as they may have felt that any response would be incriminatory. In other cases, respondents were simply unaware of what exactly was applied to their crops. However, it was typically possible to determine if a farm applied any kind of fertilizer or chemicals, as shown in Figure 10.16. Chemicals can be pesticides, herbicides, fungicides, or insecticides. Some interviewees specified particular substances, while others simply identified their general usage of chemicals. The results show that 87% of the commercial horticulture farms in the study area apply fertilizer. There was no data for the remaining 13%; however, it can be assumed that these three farms also use fertilizer, thus increasing the percentage of farms applying fertilizer to 100%. Fertilizer is most often applied through fertigation, the process of applying water-soluble fertilizer through the irrigation system.

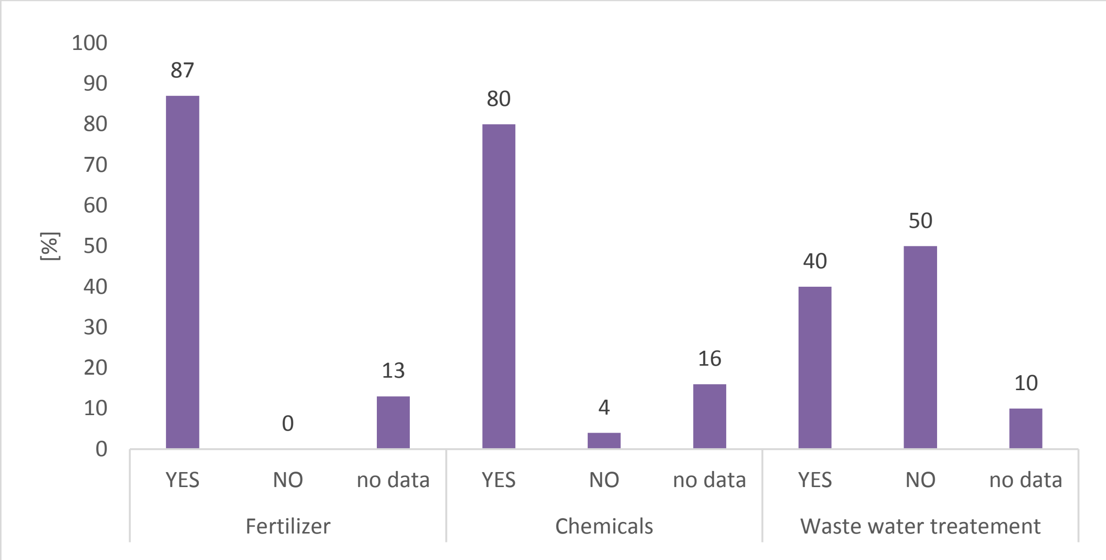

Figure 10.16: Share of medium- and large-scale horticulture farms NW of Mt. Kenya applying fertilizer and chemicals to their crops (Source: field survey 2013)

This irrigation system is a computerized drip irrigation system that allows for the distribution of very precise quantities of fertilizer and water quantities onto specific crops. Simultaneously, 80% of the medium- and large-scale horticulture farms use some sort of chemicals on their crops: typically, this consists of fungicides in humid conditions, and insecticides when it is dry (interview E14). Some farms (such as E8 and E12) started to experiment with biological and mechanical controls. In general, only class 3 and class 4, as well as biological chemicals, are used on farms. Some farms have automated GPS-based systems with weekly spray plans. An additional 40% of the farms in the study area have some kind of wastewater treatment. In most cases, this takes the form of so-called soak pits. Soak pits are covered, porous-walled chambers that let wastewater seep slowly into the ground. As it percolates, the soil matrix filters out small particles and microorganisms digested organics. Sometimes, various chambers follow one another before the water infiltrates the surrounding soil (interviews E5, E6, E17, E25). Others have constructed artificial wetlands to aid them in treating wastewater effluent (interviews E5, E11, E12, E14, E16, E25). Two companies, E16 and E22, cultivate part of their roses on hydroponic soils and catch excess water as it runs from the plastic beds into a pipe to be collected in a recycle dam. From there, the water is pumped back into the fertigation tank, mixed with 50-55% fresh water, and fertilizer levels are adjusted for it to be used for fertigation again.

Photo 10.4: Soak Pit on E8 (NL)

Photo 10.3: Wetland System on E18 (NL)

These results are solely indicative, and no conclusive information on river water quality can be drawn from them. It is clear that commercial horticulture farms in the study area utilize fertilizers and various chemicals on their crops; some, but not all, apply wastewater treatments. Hence, there is some impact that results from these practices. It would constitute a very interesting research topic to quantify uses of various chemicals and take samples of water leaving the farms to drain back into the rivers. However, this might be a difficult enterprise, as it would need the farms' collaboration on a rather sensitive topic.

10.6. Summary: River Water Resources

The total sector's mean dry season water use in 2013 was 663.1 l/s ($W_{emp.)}$ or 898.2 l/s (W_{dem}). Thus, the total sector's water use has increased since 2003 by 209.9 l/s ($W_{emp.)}$ or 235 l/s (W_{dem}). The dry season water use per hectare increased from 0.45 l/s (Wemp) in 2003 to 0.52 l/s (W_{emp}) in 2013, while Wdem-values actually decreased slightly from 0.69 l/s to 0.67 l/s.

The total sector's dry season water requirements are covered by three different water sources: storage water, groundwater, and river water. Most farms use a combination of these sources as depicted in Figure 10.5: 58% of medium- and large-scale farms are equipped with at least one dam to store harvested rainwater or floodwater during the rainy season for use during the dry season.[40] Another 58% of farms have one or more boreholes they use either as their sole water source (7 farms) or in combination with river water (2 farms), storage water (6 farms), or both (4 farms). There are 17 farms that continue to draw water from rivers; however, only four of these rely exclusively on river water. The other 13 farms combine river water with other water sources.

[40] No data for 3 farms

Storage water accounts for the largest share of dry season water demand in 2013; since 2003, it increased in importance by 14-17%, as shown in Table 10.7. The use of groundwater increased similarly by 12-15% during the past decade. Contrastingly, river water has lost importance, declining 29% with either calculation procedure.

Water Source	2003		2013	
	Wemp	*Wdem*	*Wemp*	*Wdem*
River Water	41%	62%	10%	31%
Storage Water	48%	30%	62%	49%
Groundwater	11%	8%	28%	20%

Table 10.7: Share [%] of water requirments of commercial horticulture NW of Mt. Kenya covered by the various water sources. (Source: Schuler 2004, 114; field survey 2013)

Therefore, although water use during dry seasons increased, the reliance on river water decreased in favor of storage water and groundwater, which have increased by approximately the same percentage.

Analyzing the flow duration curve of four rivers, the Naro Moru, Burguret, Teleswani, and Timau, showed that their median February flow has decreased significantly from the assumed natural state in 1961 to 1970 to the period from 2003 to 2008/2012. From the first period to the latter, the median February flow on all four rivers decreased by an average of 52%. This average covers a range from a 20% decrease (Naro Moru) to 81% (Timau River). However, of these four rivers, three already showed a median February flow decrease from the 1960s to the 1980s before commercial horticulture was established in the study area. Comparing the median February flow from the period of 2003 to 2008/2012 to the period from 1981 to 1990, just before the commercial horticulture farms started in the study area, shows that the Burguret River dropped most strongly by 52%, followed by the Timau (41%), the Teleswani (37%), and the Naro Moru (21%). From 1991 until 2002, the sector developed rapidly, expanding from zero to over 1000 hectares. This growth has since continued, however, at a much slower rate in terms of the number of companies and hectares under cultivation. Still, the median February flow depleted further from 2003 to 2012, with the Teleswani River recording the strongest decrease (19%), followed by the Timau (14%) and the Burguret (5%). As discussed in chapter 10.3.3, the median February flow data of the Naro Moru from 2003 is inaccurate due to an outdated calibration of the cross-section, and therefore comparisons between 2003 and 2013 are unreliable. If one compares the present results with those from Schuler (2004), it becomes apparent that the depletions of the Burguret (and Naro Moru) were much more striking during the first decade of horticultural production, while the Teleswani and Timau experienced a stronger reduction of their median February flow in the second decade.

The contribution of medium- and large-scale horticulture to the depletion of the various rivers varies widely depending on the calculation procedure of W_{emp} or W_{dem}; the W_{emp} values are very low compared to the W_{dem} data, as illustrated in Table 10.8.

		Naro Moru (A5)	**Burguret (A8)**	**Teleswani (AD)**	**Timau (AE)**
Mean dry season **river water abstractions** of commercial horticulture in 2013 [l/s]	Wemp	2.6 l/s	9.9 l/s	6.2 l/s	1.7 l/s
	Wdem	27.9 l/s	24.4	22.3 l/s	5.2 l/s
Contribution of abstractions to the median February river flow **depletion** [%]	Wemp	3.1%	5.5%	6.4%	2.2%
	Wdem	33.4%	12.5%	23.1%	6.5%

Table 10.8: Mean dry season river water abstractions of commercial horticulture NW of Mt. Kenya and their contribution to the median February flow depletion in the period 2003-2008/12 compared to the perido 1981-1990 (source: field survey 2013).

According to the calculation procedure W_{emp}, abstractions on the Burguret River are highest in absolute terms, while the Teleswani River shows the highest relative contribution to the river's median February flow depletion. On the Timau River, abstractions documented the lowest absolute and relative contributions to river depletion. However, according to calculations based on the W_{dem}-approach, abstractions on the Naro Moru recorded the highest absolute and relative contribution to median February river flow depletion. The Timau is, again, the river registering the lowest absolute (5.2 l/s) and relative (6.51%) contribution of its abstractions to median February flow depletion. A decade ago, the situation looked vastly different. River water abstractions on the Timau and Teleswani Rivers both registered the highest contribution to median February flow depletion, in absolute and relative terms. In terms of area under horticulture, all four rivers experienced an increase during the past decade. However, this growth is most pronounced along the Teleswani and Timau Rivers. The surrounding areas of these rivers, especially the Timau, are graced with abundant groundwater sources, probably enabling the establishment of farms despite the decrease in river water flows during the dry season.

Thus, the depletion of median February flow of the various rivers in the study area must be viewed in a differentiated manner: even though river water use during dry seasons has decreased since 2003, the potential pressure of medium- and large-scale horticulture farms on dry season river flows is high. Notwithstanding the absolute number of farms sourcing water from rivers and their respective sizes, which are both elements inducing relevant disparities in terms of pressure on dry season river water resources, the availability of on-farm water storage facilities is the most determinant factor in the impact of horticulture farming on the dry season river flows in the study area. If every farm had storage capacity to cover sufficiently its total dry season water requirements, pressure on dry season river flows would be critically diminished.[41] These findings are supported by the flow duration charts of the Teleswani River and the Timau River, where the mean dry season river water abstractions of medium- and large-scale horticulture were plotted against the February flow duration curve of the period from 2003 to 2008. According to these charts, the mean dry season river water abstractions of the sector would account for the two rivers drying up on approximately 10-20% of the days in February in the period between 2003 and 2008 (see Figure 10.12 and Figure 10.13). To confirm and support this observation, however, additional field measurements and observations are necessary.

River water demand in the study area in general is at its highest during the dry season. For medium- and large-scale horticulture farmers northwest of Mt. Kenya, water security in this period is a most pressing concern and becomes a limiting factor for the development of commercial horticulture, especially if there is insufficient water storage or groundwater access. Simultaneously, downstream populations are heavily dependent on river flows during these driest months of the year. Thus, abstractions upstream, such as those from the medium- and large-scale horticulture farms, create great amounts of conflict. Frequently, downstream users hold medium- and large scale commercial horticulture farms on the upper courses of the rivers responsible for the depleted rivers. Medium- and large-scale horticulturists are aware of these latent and expressed conflicts, and together with the endangered water security during dry season, this has led to three main conflict-mitigating strategies: first, the formation and establishment of Water Resource User Associations (WRUAs). These associations manage water resources for their river throughout the year, and especially control intakes and distribution of water during the dry season. Every medium- and large-scale farm interviewed in the study area is a member of at least one WRUA, which results in the sector's participation in 15 different WRUAs. In 2003, 15 out of 24 companies interviewed were members. The increase since the first survey is linked to the fact that the 2002 Water Act made WRUAs mandatory, and allowed the Water Resource Management Authority (WRMA) to enforce this provision. Second, technical constructs can serve as conflict-mitigating strategies, the most important being the construction of large water storage facilities. The construction of greenhouses linked to the shift to floriculture also falls into the above category. Greenhouse rooftops are equipped to gather rainwater and direct it into a gutter that leads to a dam, creating a sustainable alternative water source. Access to groundwater has increasingly become an important technical construct to mitigate conflicts regarding low river flows during the driest months of the year, as they grant a certain independence from the river. However, the exploitation of groundwater cannot be seen

[41] Access to groundwater also helps lessen the burden on river water; however, we do not know at present how the exuberant pumping of groundwater sources affects river repletion and thus, in the end, dry season river flows.

as a long-term sustainable solution. While the construction of water storage facilities is expensive and time-consuming, there is economic pressure on the horticulture companies to have secure water sources throughout the year to maintain the comparative advantage of year-round production that the study area has over other non-tropical countries exporting vegetables and flowers. Hence, the construction of water storage facilities on the various medium- and large-scale farms in the study area can be understood as an economic compulsion induced by the fear of potential market loss, in addition to the concern expressed for river levels downstream. A third mitigating strategy is the adaption of efficient irrigation practices, primarily the use of drip irrigation instead of less efficient irrigation systems such as sprinklers, overhead, or flood irrigation. In the study area, 77.6% of the commercial horticulture farms use drip irrigation, which is highly efficient and prevents unnecessary water loss during irrigation times.

In terms of water quality, the present study could not provide any conclusive information or results. Medium- and large-scale horticulture farms northwest of Mt. Kenya utilize fertilizers and various chemicals on their crops, and some apply wastewater treatments. While there is clearly an impact from these practices, this study does not analyze it in depth, and it constitutes an interesting topic for further research.

The above results concerning the declines of median February flows between 1981 and 1990 and 2003 and 2008/2012, and the contribution of the summed mean dry season river water abstractions of riparian commercial farms on the respective rivers to the depleted February flows, must be critically reviewed. The two procedures of calculating mean dry season water use, and thus, mean dry season river water abstractions, showed considerable discrepancies (W_{emp} vs. W_{dem}). The reasons are discussed in detail in section 10.2, but can be summarized briefly as the heavy dependence on data given during interviews. However, there are other critical points to underline concerning the selected method to evaluate the impact of the commercial horticulture sector's mean dry season river water abstraction on the declining median February flows between 1981 and 1990 compared to 2003 to 2008/2012. First, the mean dry season river water abstractions are bound to on-farm conditions in September and October 2013, when the data was collected. Hence, these values should be interpreted as a snapshot of reality. In contrast, the median February flow data came from daily discharge measurements over a period of 10 years, and were then aggregated to a single value that expresses the development of the river flows over this period. Thus, the comparison of this snapshot data from a single year to aggregated values from a 10-year period is problematic. However, to keep the aim of the study in mind and present an order of magnitude on the impact of medium and large-scale horticulture farm's river water abstractions during dry season on the depleted river flows, the procedure is considered adequate. The conditions that influence water requirements on the various farms, especially during the dry season, are highly dynamic and likely to have changed since the initial establishing stage of a farm. There are two main factors to underline here:

- The spatial development of each farm from its initial development stage to the present could not be obtained from the interviews, most likely because of turnover in management staff. Hence, there are some issues of information loss. However, as the whole sector expanded strongly since 1991, it is likely that individual farms also expanded. Two farms opened in 2013, one flower farm and one vegetable outgrower, and both were visited. Both farms were not yet in full production, with the flower farm still drawing up greenhouses, but the parts that were functioning were already producing and selling. Thus, it is likely that the other farms in the study area also developed in that fashion, starting with one or two hectares, and expanding the farm over time to its full potential.
- It is likely that water storage capacities did not exist on the various commercial farms from the first day, or even in the first several years of farming. Again, data on the implementation of water storage facilities for most farms was not available. A complete lack of water storage at the beginning of horticultural farming on the respective farms would imply that river water abstractions in the early stages of the farms could have been higher in comparison to the values discussed above. Nonetheless, this has changed since the beginning of the sector in 1991. In particular, new flower farms in the study area usually start constructing a water dam immediately after opening. Another important factor to set limits on the interpretation of the data presented above on river water abstractions is the years of initiation for the various farms. The years in which farms were first established along one of the four analyzed rivers vary between 1991 and 1997 (see Figure 10.7 and Figure 10.8). Thus, it is likely that there are rivers from which water was abstracted over a longer time than others.

Thus, in summary, the methodology of qualitative interviews in the highly sensitive field of the water use of the commercial horticulture sector in the study area, especially when sourced from low river flows during dry seasons, must be reviewed critically. It is possible that some of the interviewed horticulturists were tempted to gloss over their full daily water uses. However, much of this insecurity concerning the validity of the data could be reduced by providing the *Demand Based Estimates* (W_{dem}) as assumed maximum values of the respective water use per farm.

11. Socioeconomic Influences on the Region

In 2003, Schuler could not conclusively evaluate the socioeconomic influences of the medium- and large-scale commercial horticulture sector on the surrounding communities, as his results were based on the perceptions of the managers of horticultural companies. This aspect does not change for the present study. Ulrich's paper, "Export-Oriented Horticultural Production in Laikipia, Kenya: Assessing the Implications for Rural Livelihoods" (2014) answers some questions around the socioeconomic influences. In 2003, Schuler's tentative results showed that the commercial horticulture sector in the study area had become a major employer for relatively low-skilled, female, casual, or permanent labor. Female employment accounted for 75 % of the total sector workforce. The seasonality of production brought a seasonal aspect to employment in the sector. Most widespread employment schemes had a foundation of permanent employees alongside casual workers hired on a daily basis. The two major companies (including their outgrowers) dominating the sector in 2003 engaged 65% of the total sector's workforce during the high season (7,400 people), and 62% during the low season (4,500 people). According to the horticulturists interviewed, there were considerable positive economic effects on the surrounding communities resulting from the provision of employment and regular, cash income. A daily total of 832,000 KES or 10,200 EUR (exchange rate 2003) were spent on wages for workers in the commercial horticulture sector. Next to these payments, economic relationships with local suppliers of items for daily use, such as fuel, had important economic effects on the surrounding communities: settlements near the farms seemed to experience a general economic uplift. Additionally, many companies directly supported various public institutions (local police, schools, orphanages, or nurseries) and public infrastructure (roads) on an occasional basis (Schuler 2004, 155–156). Because of the lack of conclusive results, Schuler (2004, 156) formulated two hypotheses on his findings:

> **"Hypothesis 1:** The economic side effects based on the provision of employment, and hence regular incomes, to a remarkable number of labourers, led to a relevant contribution of commercial horticulture to the economic development of the surrounding communities and furthermore contribute to secured livelihoods of their employees."

> **"Hypothesis 2:** By directly supporting community projects, institutions, and the infrastructure of the communities in the study area – either in monetary terms or in kind – commercial horticulture influences the socioeconomic development of the surrounding communities in an important way."

Since 2003, the sector has grown further. Obviously, this continued increase of labor-intense horticulture production must have ongoing socioeconomic influences on the surrounding areas. The following subchapters provide a general overview of the most important issues from the horticulturists' point of view in 2013, and compare these findings to the results from 2003.

From the interviews held in 2013, three important socioeconomic influences on the surrounding communities can be identified. First, provision of employment is considered the most important effect of the sector by roughly 79% of the interviewees.[42] Second, the resulting cash influx induces economic side effects on the development of the study area, such as the creation of small businesses around the farms, according to 54% of the interviewed horticulturists.[43] Third, apart from the direct and indirect influences of monetary wealth, 61% of the farmers provide some kind of community support, such as contributing to projects and building infrastructure (e.g. roads, schools).[44] These three main socioeconomic influences of the commercial horticulture sector on the surrounding communities will now be discussed separately in more detail.

11.1. Employment

Commercial horticulture is a highly labor-intensive agricultural practice. The availability and quality of labor are very important factors that determine the success of a horticultural enterprise, as shown in sections 9.2 and 9.3. Furthermore, the provision of employment and regular cash income is important for the development of the surrounding communities. Interviewee E16 formulates it as follows:

> “We figure, you employ one person, then you are creating a livelihood for ten. […] You have one person employed and you're benefiting ten.” (Interview E16)

There are different types of employment, namely permanent, seasonal, and casual labor contracts. Permanent employees work on a contract with no time limit specified. Seasonal workers are hired for a limited time, lasting for any duration from two weeks to eight months. A seasonal employee is entitled to all the rights and benefits of employment, and his contract may be renewed. In contrast to this contract labor, casual employees are engaged and paid on a daily basis, they do not enjoy most of the benefits and rights of employment, and either party can terminate the employment relationship at the end of any day without notice. In 2003, most companies (13) companies employed both permanent and casual laborers,[45] two companies operated with permanent and seasonal labor, and one company only employed permanent workers. Figure 11.1 shows the share of employment categories in 2003 and 2013 for the high and low season. It is clear that in 2003, there was relatively high seasonality in employment linked to the seasonality of production. During the high season (left), the percentage of permanent labor decreases, while seasonal and casual labor together increase approximately 30%. In 2013,

[42] E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E19, E20, E21, E23, E28
[43] E5, E7, E10, E14, E15, E16, E17, E22, E25, E27, E28
[44] E1, E5, E7, E8, E9, E11, E12, E14, E15, E16, E19, E22, E23, E24, E25, E26, E27
[45] According to Schuler (2004, 137), in some of his interviews casual labor and seasonal labor may not have been strictly distinguished, which could have led to distortion in that particular category. For instance, it was not clear if a casual labor working for several weeks in a row would be considered a seasonal worker by the horticulturist. However, Schuler estimated his figures as coherently as possible despite this methodological objection.

most companies (15) operate with permanent and seasonal labor, seven companies employ only permanent workers, three companies hire solely seasonal labor, two companies hire across all three employment categories, and only one company employs permanent and casual laborers. Although there is still seasonality to employment in 2013, it is much less pronounced, with an approximate increase of 12% in seasonal labor and a 0.04% increase in casual labor. This is because many farms today prefer permanent employment, as the relationship with permanent laborers is better and reliability increases in long-term arrangements.

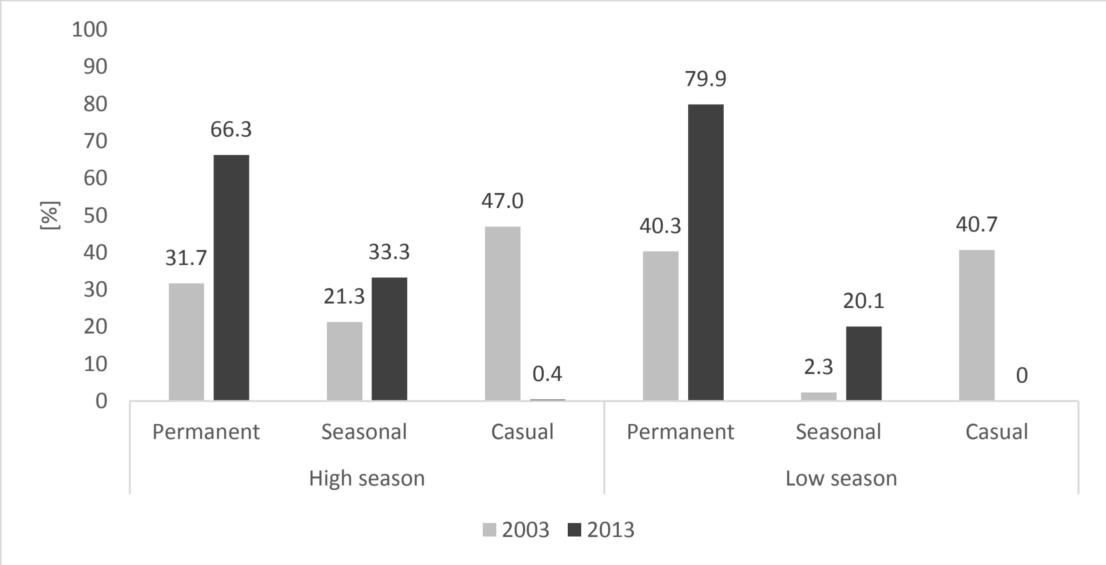

Figure 11.1: Share [%] of employment categories during high season (left) and low season (right) of the commercial horticulture sector NW of Mt. Kenya in 2013 and 2003 (Source: Schuler 2004, 137; field survey 2013)

Figure 11.2 further details the number of employees in each employment category. Mean annual employment almost doubled since 2003; this is notable, considering that the area under horticulture only increased by roughly a third in the past decade (see chapter 8).

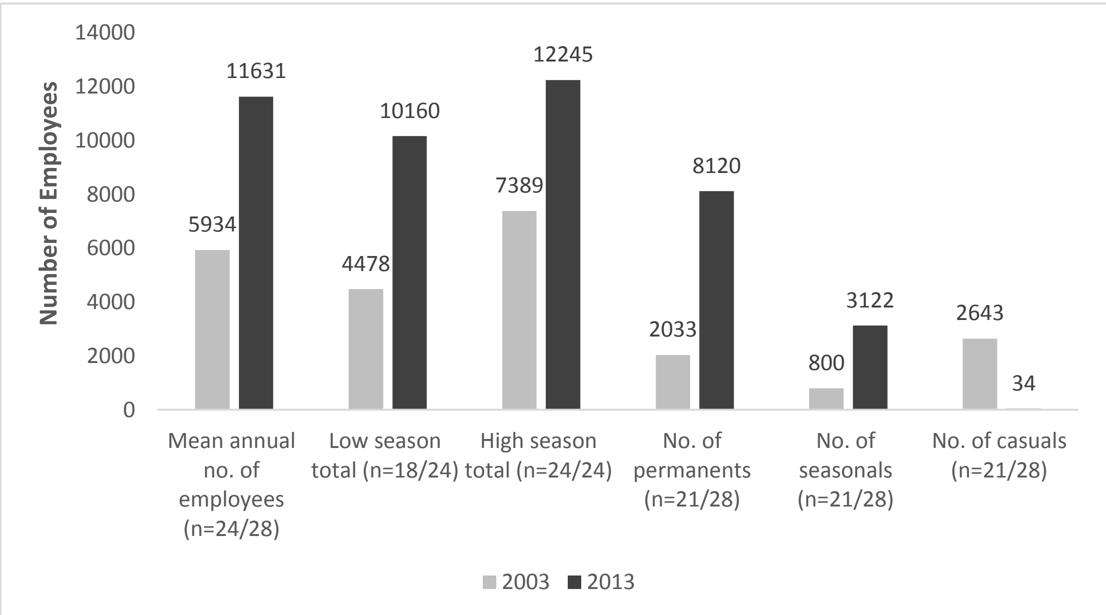

Figure 11.2: Number of employees by category of the commercial horticulture sector NW of Mt. Kenya (Source: Schuler 2004, 137; field survey 2013)

An explanation for this large increase is, again, the shift from vegetable production to floriculture: while one hectare of vegetable crops needs approximately 5 workers, one hectare of floriculture requires about 15 workers. The higher employment rate per hectare on flower farms is clearly shown in Figure 11.3.

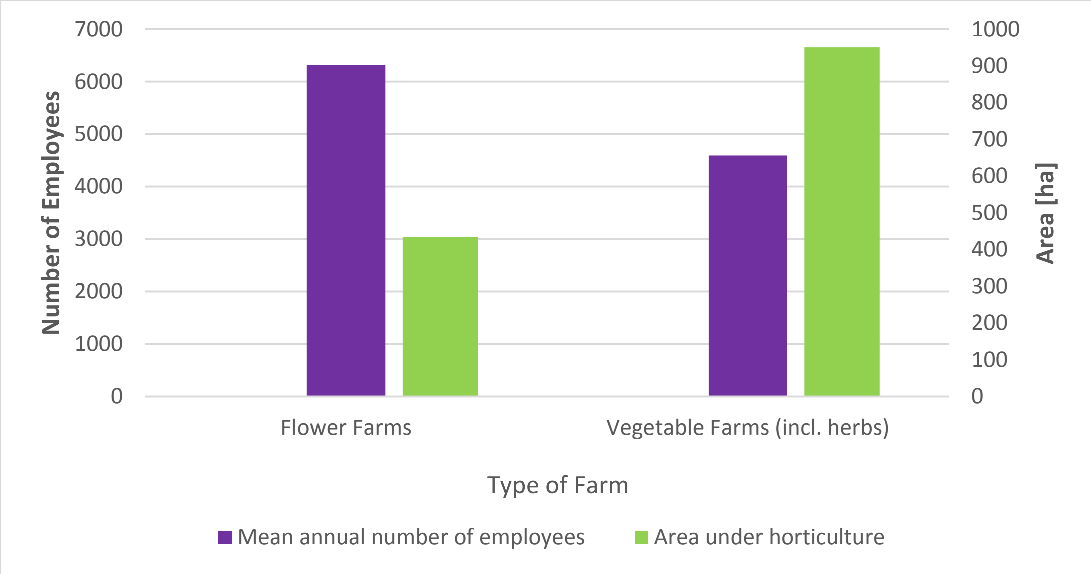

Figure 11.3: Number of employees and average area under horticulture on flower and veegetable farms (Source: field survey 2013)

Concurrently, vegetable production is subject to greater seasonality in production that prompts seasonality in employment. Floriculture, however, is a more constant business throughout the year. Hence, the flower farms not only need more workers per hectare, they also need them throughout the year. Vegetable farms need less people per hectare, and they have periods of lower production. This is strongly expressed in Figure 11.2, where the difference between low and high season employment in 2013 is smaller compared to 2003. From the interviews during the 2013 field survey, it also seems that the large vegetable farms that export on their own favor permanent and seasonal employment rather than casual (e.g. interviews E15, E24, E27, E28). Concurrently, in 2013 the numbers of permanent and seasonal employees are much higher than in 2003, while the number of casual workers clearly decreased.[46] Concerning gender, female labor plays an important role. In 2003, approximately 75% of the employees were female. Female labor mostly centered around weeding, planting, grading, and picking, activities predominantly based on casual contracts, whereas male labor activities in farm management, field and labor supervision, irrigation, and spraying lent themselves more to seasonal or permanent employment. By 2013, the percentage of female labor reduced to roughly 50%. It is not clear why this decrease occurred. Additionally, in 2003, most farmers indicated that workers had migrated from somewhere and were attracted to the area because of the horticulture farms and potential

[46] The numbers of the various employment categories do not add up to the total. This is due to inconsistencies in interview indications in 2003 and 2013. However, the order of magnitude is adequate, and gives a good indication on the situation.

employment possibilities. In 2013, 75% of interviewed commercial horticulture farmers state that the bulk of their workers come from the immediate area, while most of the rest come from Meru County and only a few migrate from farther away.

In 2003, the commercial horticulture sector was dominated by two companies, C16 (now E11) and C17 (now E15). Together they employed 62% (low season) to 65% (high season) of the total labor in the study area. Today, E11 has converted to a flower farm of considerably less size, while E15 generally consolidated its production on two, rather than six farms, also reducing its total farm size. However, E15 remains the largest employer in the study area: roughly 25% of all the employees in commercial horticulture in the study area work for company E15. The largest flower farm in the study area is E17, and it employs approximately 11% of all people working in the industry. These two are thus the most dominant companies, although their supremacy does not match that of C16 and C17 in 2003.

Photo 11.1: A worker checking on pea crops on E24 (NL)

Figure 11.4 shows the number of employees per farm during the high and low season. Seasonality in production decreased, as did seasonality of employment. Farms that employ only permanent labor show a constant number of employees. Farm E15.1 has the largest number of workers: it is the largest vegetable farm in the study area, but also cultivates lilies, operating on a total 250 hectares. Furthermore, the farm has its own on-farm packhouse, which demands a great number of employees. E17 is the largest flower farm in the study area, operating on 86 hectares at 15 people per hectare.

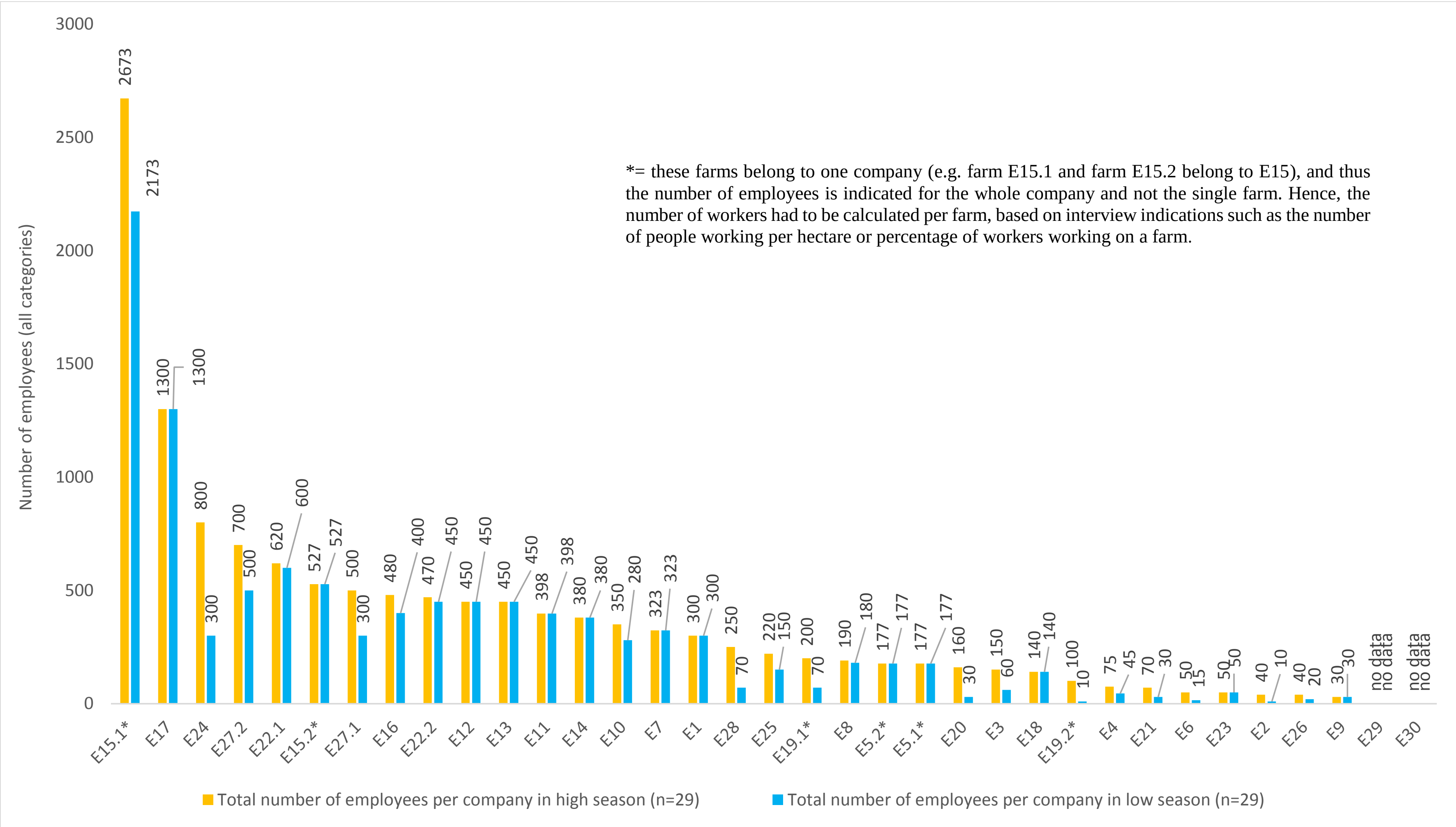

Figure 11.4: Number of employees per farm (all categories) during high and low season (source: field survey 2013)

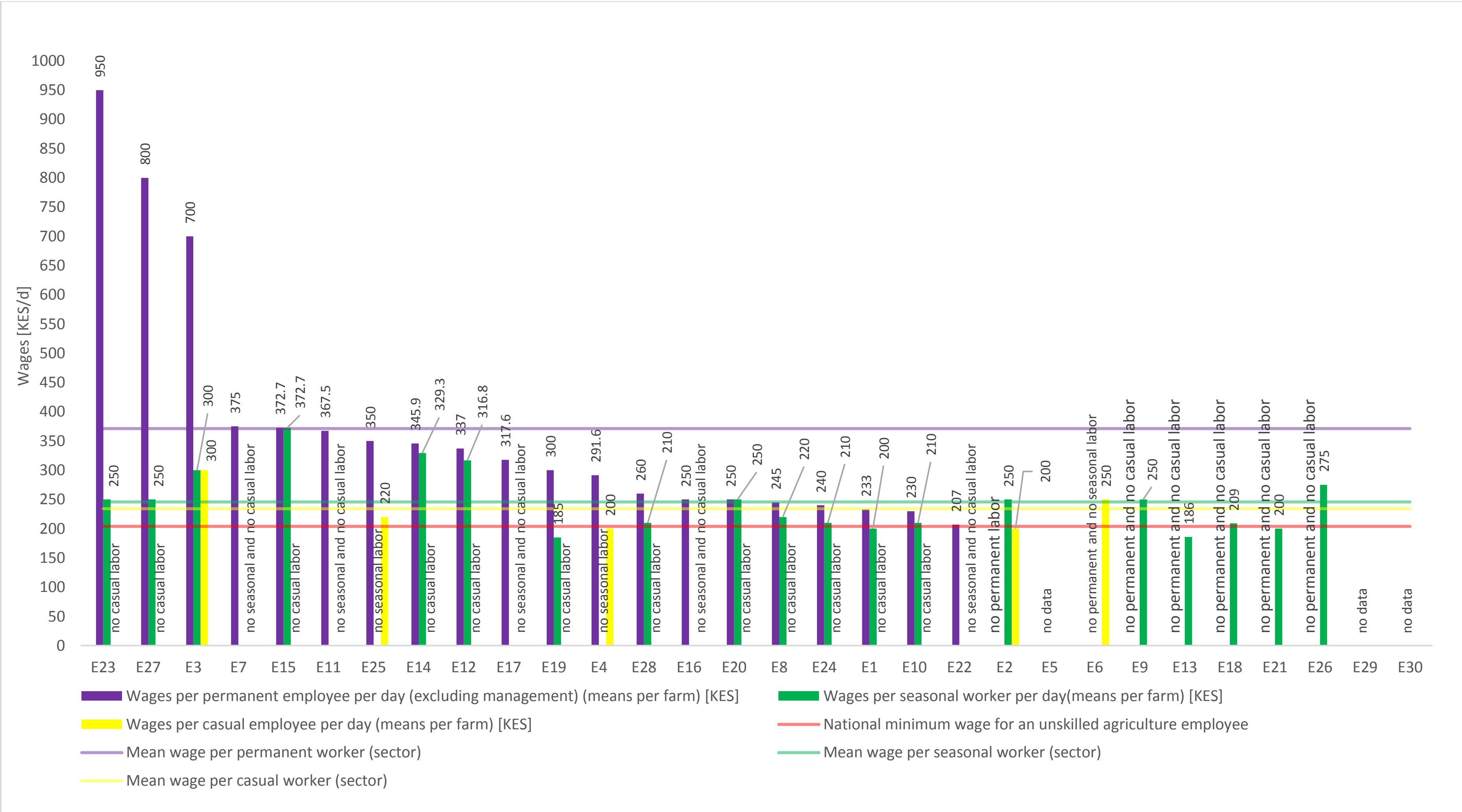

Figure 11.5: Mean daily wages per farm and employment categories: permanent employees (excluding management), seasonal and casual workers, and means for the sector, as well as the national minimum wage for an unskilled agriculture worker (Source: field survey 2013; (Kenya Law 2013))

Figure 11.5 shows the mean wages per employment category per farm. As of 2013, the minimum wage for an unskilled worker in Kenya is 203.85 KES (Kenya Law 2013), shown as the red line in Figure 11.5. The high wages for permanent employees in companies E23, E27, and E3 are probably for workers with a high level of responsibility, such as farm supervisors, rather than average, unskilled workers in the fields or the packhouse. The mean wage for permanent employees across the sector is 371 KES, for seasonal employees it is 246 KES, and for casual employees it is 234 KES. Thus, the sector pays workers more than the national requirements. However, compared to 2003, real wages have dropped. The real wage removes the effect of rising prices, and shows what the wage is worth in real terms of purchasing goods and services. With real wages, one can compare wages in different years, as in Figure 11.6.[47] Hence, in 2013

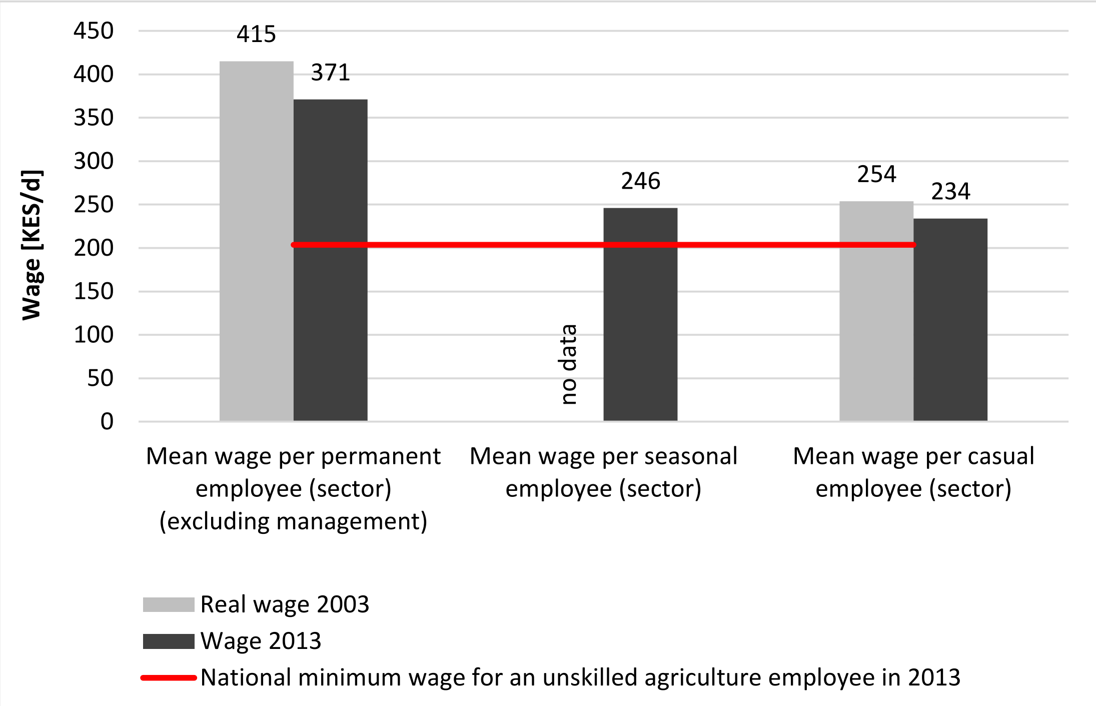

Figure 11.6: Mean daily wage in 2013 and 2003 of the commercial horticulture sector NW of Mt. Kenya, as well as national minimum wage for an unskilled agriculture employee in 2013 (source: Schuler 2004, 141; field survey 2013; Kenya Law 2013)

a worker would need to earn 415 KES per day in order to have the purchasing power he had with 175 KES in 2003 (mean wage per permanent employee in 2003 as per Schuler 2004, 141. This reduction in real wages is due to inflation in Kenya. Various interviewed horticulturists underlined that although the internal inflation of the Kenyan Shilling is profitable for them, because they earn their profit in Euros, this has led to workers demanding higher wages (E1, E7, E11, E12, E14, E27). Some laborers work on a task payment model (E1, E3, E4, E11): usually, this meaning that there is a minimum volume of crops to be picked per day for which a guaranteed minimum daily wage is paid. On top of this minimum daily wage, workers can

[47] Consumer Price Index (CPI) in 2003 was 59.06 and CPI in 2013 was 140.11. Real wage was calculated with the following formula: *real wage = (nominal wage in year 1/ CPI in year 1) * CPI in year 2* (KNBS 2014).

earn a bonus per additional kilogram picked. In this case, wages will vary. Similarly, companies with on-farm packhouses task packhouse workers with a definite number of rose bunches to be assembled, for example, and additional bunches are rewarded with a bonus. Some workers hurry to pick their mandatory volume or bunch their number of roses and then leave early, especially female laborers who have children or any workers who have their own plot to which they must attend. Most companies do not only provide labor, but various complementary services as well. In 2003, the services detailed in Table 11.1 were provided to workers:

Services	Transport from centers to the farms	Saving schemes	Training with certificates	Free or subsidized meals	Medical services	On farm housing
Code of Company	C16, C17, C18, C24	C17	C17	C16, C17, C18, C19, C3, C4, C1,	C12, C16, C17, C21, C24, C25, C3, C5, C7, C8, C1	C1, C9, C8, C4, C24, C11, C20

Table 11.1: Services provided to laborers in commercial horiculture companies NW of Mt. Kenya and companies providing the respective services in 2003 (Source: Schuler 2004, 142)

Hence, roughly 17% of the companies in the study area in 2003 provided transport for their workers from town centers such as Nanyuki and Timau to the farm. Another 4.2% provided saving schemes and trainings with certificates. Almost a third of the companies offered free or subsidized meals, and another 29% had on-farm housing for some of their workers. Of the 24 companies interviewed in 2003, 46% provided some kind of medical services to their worker. The number of companies offering various services to their employees has increased considerably in the past decade, as shown in Table 11.2.

Services	Transport from centers to the farms	Saving or loan schemes	Training with certificates	Free or subsidized meals	Medical services	On farm housing	Social activities (sports clubs, etc.)
Code of Enterprise	E3, E5, E8, E10, E13, E14, E15, E17, E19, E21, E22, E24, E25, E27, E28	E5, E6, E8, E11, E14, E25	E6, E12, E14, E19	E3, E7, E8, E10, E14, E15, E16, E17, E21, E22, E24, E25, E27, E28	E1, E5, E6, E7, E8, E11, E12, E13, E14, E15, E16, E17, E19, E22, E23, E24, E25, E27, E28	E1, E5, E8, E13, E16, E17, E22, E23	E1, E5, E7, E11, E15, E16, E24, E28

Table 11.2: Services provided to laborers in commercial horiculture companies NW of Mt. Kenya and companies providing the respective services in 2013 (Source: field survey 2013).

Today, roughly 54% of companies offer transportation. Another 21% provide saving or loan schemes, which have become very popular measures. Nearly a sixth offers various training with the possibility of gaining certificates and 50% of the interviewed companies offer free or subsidized meals. Additionally, 68% provide medical services to their workers. On-farm housing is possible at 29% of the companies, but is limited and not available to all workers. Of the 28 interviewed companies, 29% additionally offer social activities for their workers, such as sports clubs. These are services provided by the companies to their employees, and are not meant for people outside of the company.

11.2. Economic Side Effects of the Commercial Horticulture Sector

The interviewed horticulturists perceive the provision of employment, and thus cash income, as the most relevant socioeconomic impact of the horticulture industry on surrounding communities (mentioned by 79% of interviewees). The mean annual employment in the study area is 11,631 people per day. Multiplied by the approximate mean wage per laborer of 308 KES per day (mean of permanent mean and seasonal mean, see Figure 11.6), the commercial horticulture sector injects roughly 3,582,348 KES per day into the study area through wages (approximately 31,589 EUR).[48] In contrast, ten years ago the total in salaries paid, considering inflation in Kenya, amounted to roughly 1,973,781 KES (approximately 17,400 EUR). According to 54% of the interviewees, most of this money seems to be spent in the study area itself, which has seen an upsurge in economic activities around the farms. This takes place in various manners:

- Farm gates of companies, especially those situated along a main road, have become gathering points with various small shops close to the gate. People sell food and other items of daily need, destined for the workers leaving the farm after hours.
- Many workers live too far away from the farm to walk or cycle there, and hence, they must be transported from their homes to the farms in the morning and back in the evening. This has led to an increase in employment and entrepreneurship in the various forms of transportation. This is mostly visible in an increase in *Matatus*, the privately owned public commuter system. These small buses drive along a specific route and gather commuters for a fee. Simultaneously, motorcycle taxis called *Boda Boda* have become more prevalent. Although these are more expensive than a ride in a *Matatu*, they are still cheaper than car taxis.
- Settlements close to farms have either grown considerably or emerged as new construction, turning into effective labor quarters. This eliminates the need for costly transportation to and from the farms. An example for this is Likii Village, which has considerably expanded and grown since the establishment of the neighboring farm in 1996. With these new settlements, new shops and new transportation businesses come to tend to the needs of the inhabitants.

[48] 1 KES = 0.008818 EUR on 24.10.2014 according to http://www.xe.com

Apart from economic spillovers based on employment and the influx of cash, there is a spillover of knowledge to small-scale farmers. As mentioned previously, many commercial horticulture exporter companies contract small-scale outgrowers in order to guarantee their production and spread their risk in case of climatic or economic shocks. These outgrower schemes seem to be attractive for small-scale farmers too, since the cash returns are better on horticulture crops than on their traditional crops. Thus, these higher incomes may again fuel economic side effects in the sense that more money is available to be spent in the study area. Additionally, visiting agronomists from the large commercial farms provide the benefit of a trickle-down effect of agricultural knowledge (interviews E11, E14, E15, E25).

Finally, the commercial horticulture farms have high demand for various inputs. Specific materials such as such as pipes and greenhouse building material, as well as farm inputs such as fertilizer, are purchased directly from Nairobi since they are not available in the study area. However, residents also spend considerable amounts of money in the surrounding communities, mainly on food for the farm canteens but also on various wooden and hardware products, creating further economic spillover effects.

11.3. Community Support by the Commercial Horticulture Sector

Many of the interviewees provide additional, direct community support on a voluntary basis for various issues. The companies are often requested by people or institutions to contribute to a specific project (interviews E7, E8, E11, E15). There are four main areas where the various companies contribute:

- Maintenance of public road infrastructure is an important field of investment. Approximately 36% of the companies maintain road infrastructure from the main tarmac road to the farms, as this has obvious benefits for their own business.[49] However, communities living along these roads also benefit from these investments, because in some cases there was no access road at all before the farm established itself in the area.
- Schools and hospitals are actively supported by 46% of the interviewed companies, whether this support takes the form of monetary funds, infrastructure building such as classrooms, or helping to run the institution, for example by providing food to orphanages.[50]
- The support of community police projects is also common. Security is a big issue throughout Kenya, but also specifically in the study area. Security guards must protect properties, and burglars or raiders are very common. Community police projects have

[49] E7, E9, E11, E13, E14, E22, E23, E24, E25, E26
[50] E1, E5, E7, E11, E14, E16, E17, E22, E23, E24, E25, E27, E28

arisen in past years due to frustrations with the official police. Members pay these community police projects a monthly fee, which guarantees them regular check-ups by community police cars and fast reaction in case of a raid. Most farms are members and approximately 21% support these projects, either in monetary terms or by providing vehicles or free fuel.[51]

- As we have seen, water is a contentious issue, and communication and interaction with the community is of great importance. All farms need to be a member of WRUAs on a mandatory basis, and approximately 25% of the interviewed companies hold an important position within their WRUA.[52] Furthermore, company E25 directly sponsors the WRUA Ngare Ndare, while company E14 pays the executive director's officer salary and provides the WRUA Likii with office space. Other companies, such as E15 and E16, invest in infrastructure for the WRUA, such as pipes, or help build a community dam. Another 25% of the commercial horticulture companies offer occasional support, such as water points during droughts, or help building and maintaining infrastructure when needed.[53]

Exact figures on how much direct community support the various companies provide could most often not be obtained. This was particularly difficult because many activities are paid in kind. However, E15, E16, and E17 provided an approximate value of 6,600,000 KES (approximately 58,199 EUR) in total that the three farms had spent on direct community support. Furthermore, three farms (E7, E15, and E22) have the Fairtrade label, which does various direct community projects on their behalf.

The motivations to provide community support go beyond the fact that institutions require help. Many companies feel a need to be part of the community and to tackle problems together with them (E5, E11, E15, E16, E17). Furthermore, many see community service as an important aspect of creating and maintaining a good relationship with the community (E8, E11, E15, E16, E24, E25). There seems to be an awareness among the commercial horticulture farms in the study area that they have a social responsibility, and that taking it seriously and acting together with the community to tackle problems and find solutions is "[…] very rewarding" (interview E17).

11.4. Summary: Socioeconomic Influences

The commercial horticulture sector northwest of Mount Kenya has a significant impact on the surrounding communities. According to the view of the interviewed horticulturists, the most

[51] E1, E5, E11, E12, E14, E27
[52] E7, E11, E14, E16, E22, E23, E25
[53] E1, E8, E11, E16, E19, E22, E25

important effect is the provision of employment, and thus regular cash income. Another important factor is the support various farms provide to local institutions such as schools, hospitals, and local police projects.

Interesting developments have taken place in employment since Schuler conducted his study. In 2003, farms mainly employed permanent (30-40%) and casual labor (40-47%), with a gender divide of 75% female labor. Ten years later, the majority of employees are permanent (66-80%) and seasonal (20-33%), with a much more balanced gender divide of approximately 50% female workers. Thus, in 2013 the share of permanent and seasonal employees was much higher than in 2003, while the share of casual labor strongly decreased. As stated in many interviews, horticulturists prefer long-term engagement from their workers, as this leads to more trusted and reliable relationships with employees. In absolute terms, the number of mean annual workers in the commercial horticulture sector increased from 5,934 to 11,631. This increase partially came from the general growth of the sector, but was most likely enhanced by the growth of the floriculture sector in the study area. Flower farms need an average of 15 people per hectare, while vegetable farms employ roughly 5 people per hectare. Furthermore, there is no seasonality in floriculture, and hence, employment is constant compared to vegetable production, which experiences clear high and low seasons that lead to a seasonality of employment. In general, the seasonality of employment seems to have lessened since 2003. However, sample sizes for low season employment are lower in 2003 than for high season employment. Thus, low season employment might have been higher at that time, too. Furthermore, high and low season employment are not completely congruent with high and low season in vegetable production, as there is a considerable labor demand for field preparations during the off-season, such as weeding. Still, the high season is generally understood as the dry season at the beginning of the year, while the low season refers to the European summer.

Wages for workers depend on the employment category. Mean wages for permanent employees per day are 371 KES (currently 3.26 EUR), for seasonal employees the daily wage amounts to 246 KES (currently 2.16 EUR), and casual employees gain 234 KES (currently 2.06 EUR) per day.[54] The minimum wage in Kenya for an unskilled worker in agriculture is 203.85 KES. However, since 2003, real wages have decreased due to inflation. The purchasing power of wages from 2003 was higher than the current wages' purchasing power. Most farms provide further services to their employees such as transport to and from the farm, subsidized meals, loan schemes, and medical services. In total, the commercial horticulture sector northwest of Mount Kenya spends 3,582,348 KES per day in wages paid in the study area (approximately

[54] 1 KES = 0.008879 EUR on 29.10.2014 according to http://www.xe.com

31,495 EUR).[55] This cash influx has considerable economic side effects in the study area. The interviewed horticulturists observed a general economic uplift in the settlements close to horticulture farms, such as in Timau and Ngusishi. Close to the farm gates, many new small businesses have developed, most prominently to sell food and other items of daily need to the workers leaving the farms. The interview respondents also described an upsurge in the transportation business, especially for *Matatus* but for *Boda Bodas*, as well. Apart from the provision of labor and the ensuing economic side effects, most farms support the surrounding communities directly in their various projects and institutions.

Conclusively, it can be said that the commercial horticulture industry northwest of Mount Kenya contributes substantially to the development of the study area. However, for a more detailed picture of the cause-effect relationship between the establishment of the commercial horticulture sector and the socioeconomic development of the study area, other research methods would be necessary. In particular, one would need to investigate the view of farm workers, and how their livelihood has changed due to their employment in the sector. However, this exceeds the scope of this research. If the present study is conducted again in 10 years, I would recommend eliminating this chapter altogether and making it the focus of a second master thesis, where the researcher investigates the perspectives of the horticulturists, the workers and communities neighboring commercial horticulture farms in more depth.

[55] In 2003, the amount of salaries paid were, considering inflation in Kenya, roughly 1,973,781 KES (approximately 17,350 EUR).

Part V: Conclusion

Part V is the final part of the study and concludes the research. Chapter 12 summarizes and presents selected key findings from the commercial horticulture sector northwest of Mount Kenya. In chapter 13, emphasis is placed on linking the empirical results of the study to the theoretical frameworks set at the beginning of this thesis.

12. Key Findings

Extended discussions on the respective topical sections were presented after each chapter. Thus, it is recommended to consult sections 8 (inventory and structure), 9 (development), 10 (impact on river water resources), and 11 (socioeconomic influences on the region) for further summaries and analysis of the results of the respective focal sections. The present chapter focuses on bringing forth selected key findings about the commercial horticulture sector northwest of Mount Kenya.

12.1. Inventory and Structure

In 2013, there were 30 companies operating on 35 farms in the study area. This represents five more companies and seven more farms than a decade ago. The total area under cultivation increased from 1085 ha in 2003 to 1385 ha in 2013. However, the average area under horticulture per farm remained the same, at roughly 39 ha.

Shift to floriculture: The single most important change in terms of structure in the horticulture industry in the study area since 2003 is the shift from a purely vegetable-dominated sector to an increasingly important floriculture subsector focused on roses. This shift has had many consequences for the whole horticulture sector in the study area, namely:

- *Reduction of farm sizes:* Returns on roses, the main flower crop grown in the study area, are much higher than on vegetables. Thus, flower farms can operate on fewer hectares and still generate more profits.
- *Decreased importance of medium- and large-scale outgrowers:* No flower farm in the study area contracts outgrowers. Thus, the number of medium- and large-scale vegetable outgrowers decreased from thirteen to seven, probably because the entire sector in the study area has shifted its orientation away from vegetables.
- *Orientation towards the Netherlands as an export market:* Most flowers produced in the study area go to the auction, FloraHolland, in the Netherlands. Thus, this country has become drastically more important as an export market destination. In 2003, the

bulk of the produce from the study area was delivered to the UK, which remains the most important export market for vegetables in 2013.

Larger vegetable farms: There are still a substantial number of vegetable farms in the study area. Those that remain are, on average, larger than in 2003; their size increased by approximately 9.75 hectares. The golden age of vegetable horticulture is over, as underlined by several interviewees, and thus the only way to remain profitable is to go large and add value.

Emergence of herb production: A new development in the study area is the emergence of commercial farms producing herbs for export markets. There are currently three farms producing only herbs. One of the farms processes them into beauty products and sells them in Kenya, Tanzania, and Uganda. However, the other two export them to European supermarkets. It is plausible that the herb segment will continue to grow. Most likely, the existing vegetable farms will cover this demand and growth, as many have already begun to do.

12.2. Development of Commercial Horticulture

Commercial horticulture production destined for export markets initiated in 1991 in the study area as a result of collaboration between a local family owning farmland and Homegrown (K) Ltd., then the Kenyan horticulture market leader, as Schuler detailed in his thesis (2004, 75–80). The growth of the sector from 1991 to 2002 was much higher in terms of the area under horticulture and farms opening than the one from 2003 to 2013. The various factors enabling the sector's development on the international, national, and regional level have scarcely changed since 2003, and are:

- Increased market demand in Europe
- Good quality of transportation infrastructure
- Preferential trade agreements (Cotonou Agreement and EPAs) between the EU and ACP countries
- Agricultural market liberalization
- Governmental non-interference and export incentives
- Advantageous growing conditions in the study area (altitude and climate, availability of large and fertile land resources, availability of water)
- Advantageous socioeconomic conditions in the study area (availability and cost of labor)

The floriculture sector again deserves special mention: the demand for Kenyan flowers has risen in the past years due to various reasons. First, Ethiopia's floriculture export business suffered under the effect of the economic crisis in 2007-2008. Second, production costs in Ecuador and Colombia, the two major flower-exporting countries, increased, making export to Europe less profitable. Third, Dutch rose production decreased in recent years because of production costs, particularly including the cost of energy to heat greenhouses and illuminate them in wintertime. Thus, Kenya has a comparative advantage vis-à-vis those countries that led to increased demand for Kenyan flowers. The growth of the horticulture sector in the study area is in line with developments in the horticulture industry across Kenya.

In terms of constraints for the sector's development, the most important aspect is market demand. Vegetable farms, in particular, suffer from stringent requirements concerning various farming practices such as maximum residue levels (MRLs) in the use of chemicals, and the social welfare of their labor. Furthermore, the availability of water during dry seasons remains a big issue. Many farms circumvent it by developing enough water storage capacity or by using groundwater. However, without this infrastructure, commercial horticulture would not be possible as it is today in the study area.

12.3. Implications for River Water Resources

The total sector's mean dry season water use per day has increased from 357 l/s (W_{emp}) or 567 l/s (W_{dem}) in 2003 to 663 l/s (W_{emp}) or 898 l/s (W_{dem}) in 2013. The two respective values are based on two different calculation procedures discussed in chapter 10.2. The numbers presented here must be interpreted as orders of magnitude rather than specific figures, due to the heavy dependence of the calculations on interview specifications about the water use during dry seasons and various general assumptions made based on water-related interview specifications. However, through the cross-validation of the specified or calculated values from the interviews (W_{emp}) with the *Demand Based Estimate* of the water use per farm (DWd adapted from MoWD 1986 and FAO 1977, both cited in NRM3 2003, 17), the presented data can be interpreted as the consistent range of true values. This increase in the total sector's mean dry season water use per day is consistent with the general growth of the sector. The mean dry season water use per farm has also increased from 12.8 l/s (W_{emp}) or 19.3 l/s (W_{dem}) in 2003 to 20.1 l/s (W_{emp}) or 27.2 l/s (W_{dem}) in 2013. However, the mean dry season water use per hectare shows only small differences: it increased from 0.45 l/s in 2003 to 0.52 l/s in 2013 (W_{emp}), and decreased from 0.69 l/s in 2003 to 0.67 l/s in 2013 (Wdem). If one were to round these figures to one decimal point, there would be no visible difference.

The most important finding of the study regarding the impact of the sector on river water during dry seasons is that although water use in total has increased, the dependency on river water has decreased. In 2003, roughly 39-60% (depending on the procedure of calculation, either W_{emp} or W_{dem}) of the farms relied on river water for irrigation, 32-48% sourced their water requirements from water storage, and 8-11% pumped groundwater through boreholes. In 2013, only 10-30% of the farms rely on river water during dry season, while 49-62% source their water from storage and 20-28% pump groundwater from boreholes. Thus, there has been a 29% decrease of river water use, while there was an increase of storage water use by 14-17% and groundwater use by 12-17%. In sum, although water use during dry season increased for the sector as a whole dependence on river water resources has decreased in favor of storage water and groundwater, which have increased by approximately the same amount.

The evaluation of the impact of commercial horticulture on the depletion of median February flows of the four rivers Naro Moru, Burguret, Teleswani, and Timau from the decade 1981 to 1990 (before commercial horticulture started in the study area) to the period from 2003 to 2008/2012 (when the sector was established but still growing) brought forth two key findings. They are more or less in line with Schuler's results from 2003:

First, the impact of commercial horticulture on the depletion of the median February flows of the four analyzed rivers varies greatly from river to river. In absolute terms, river water abstractions of commercial horticulture in 2013 ranged from 1.7 l/s (Timau River, W_{emp}) to 27.9 l/s (Naro Moru River, W_{dem}); while the percent contribution to the depletion of the median February flow stretched from 2.2% (Timau River, W_{emp}) to 33.4% (Naro Moru River, W_{dem}).

The four rivers vary greatly in terms of the area under horticulture and number of farms using water from them. The most important factor deciding the impact of commercial horticulture on the rivers, however, is the availability and size of water storage facilities, and to some extent, access to groundwater. Without the availability of water storage and groundwater, the massive demand for water during dry season would apply heavy pressure to the rivers. Farms using water from Teleswani River would probably abstract all the river water available during February low flows; farms along Timau River would need roughly three times the amount of the 2003 to 2008 median February flow.

The second key finding, already formulated by Schuler, is that the median February flows of three of the four rivers analyzed already started to deplete before the first commercial horticulture farm began production in the study area. Thus, stakeholders and abstractions other than medium- and large-scale farms must have contributed to the depletion of the median February flows over the past three decades (1981 to 1990, 1993 to 2002, and 2003 to 2013).

Furthermore, the actor-category of commercial horticulturist is well aware of water-related conflicts. They are often held responsible for depleted water resources by other water users of the respective rivers because they are large, corporate users. The implementation of various conflict-mitigating strategies has considerably helped to defuse conflicts. The most important measure is the formation and establishment of WRUAs along the various rivers that manage and allocate the river water. All the farms in the study area participate in a WRUA. Moreover, the storage of floodwater or harvested rainwater is perceived as a conflict-mitigating strategy by the interviewed horticulturists, as it grants them crucial independence from river water, especially during the dry season. Access to groundwater has a similar impact, although the effect of the exuberant digging of boreholes on river replenishment is not yet known, and may have a negative impact. Not all farms have storage facilities or boreholes, but a majority does have an alternative water source to river water. These two main conflict-mitigating strategies are thus reasonably well implemented. They must be considered against the background of jeopardized water security: for the commercial horticulture sector in the study area, insufficient water availability means that they cannot conduct business. Thus, the construction of water storage facilities and the digging of boreholes on the various medium- and large-scale farms are also a measure of security for their future existence, and thus that of the whole commercial horticulture sector northwest of Mount Kenya.

12.4. Socioeconomic Influences on the Region

The data presented in this chapter does not allow for a concluding evaluation of the socioeconomic influences of the commercial horticulture sector on the region and their communities. This is due to the selected method, which only investigated the commercial horticulturists' point of view, an analog to what Schuler (2004) concluded a decade ago. He then proposed to formulate two hypotheses instead, which are based on the results from the interviews. These two hypotheses were adopted for the present study, as they are still valid. The first hypothesis states that the commercial horticulture sector in the study area has great economic side effects on the region, mainly because of its provision of employment, and thus regular cash income, to a large number of people. Therefore, the sector relevantly contributes to the economic development of the area and helps to secure the livelihoods of its employees. True to this, the commercial horticulture sector employed 11,631 people in the study area in the year 2013 (compared to 5,934 in 2003). The majority of employees are permanent (66-80%) and seasonal (20-33%), with a very balanced gender divide at approximately 50%. In terms of wages, the commercial horticulture sector spends approximately 3,582,348 KES (approximately 31,495 EUR) per day in salaries that then flow into the study area. This cash influx results in major economic side effects, such as the creation of new businesses close to farm gates that sell food and goods for daily use to the workers, as well as an upsurge in the transportation businesses, especially *Matatus*, the local commuter system. Second, many medium- and large-scale horticulture companies directly support community projects, various institutions (e.g. schools and hospitals), and help maintaining infrastructures (e.g. roads), either in kind or monetary terms; again exercising a heavy influence on the socioeconomic development of the study area. Hence, Schuler's hypotheses are still valid today.

13. Synthesis

Within its first decade from 1991 to 2002, the commercial horticulture sector northwest of Mt. Kenya became a major stakeholder in the Upper Ewaso Ng'iro Basin. It has further reinforced this position in the past ten years. The industry affects and influences the surrounding communities in economic, sociocultural, and ecological terms. Hence, the actor-category of medium- and large-scale horticulture farms likely has one of the most critical impacts on the socioeconomic development of the study area. Further studies in this subject area are thus recommended.

Furthermore, the sector itself has undergone important changes in the past decade. The industry shifted from a sector dominated by vegetable horticulture to an increased focus on floriculture, and especially roses. This has had various effects, especially on the seasonality of production. The heavy orientation toward vegetable production and UK export markets with seasonally-fluctuating demand in 2003 had led to a seasonality of production in the study area according to the motto "dry season is high season" (Schuler 2004, 156). These were strong, opposing patterns: high production due to high export market demand during the period of the year when river water flows are lowest, thus generating immediate and potentially destructive pressure on the local river water resources. The shift to floriculture, where there is no such seasonality, has therefore considerably lessened these variations. Floriculture produces constantly throughout the year and uses slightly less water than vegetables. It is also a crop grown always under drip irrigation. Thus, it is safe to assume that due to this shift, there is less pressure on rivers during the dry season. However, a number of vegetable farms still operate in the study area today, so the above scenario remains a concern. These high water requirements of the commercial horticulture farms in the study area, and the potential and effective pressure they exert on the upper reaches of Ewaso Ng'iro River, are lessened considerably by the addition of water storage facilities on farms. Many of the farms in the study area have already implemented this solution, since the heavy decrease in river water resources during dry seasons jeopardizes the economic sustainability of the various farms. Few farms remain that rely only on river water, without an alternative. The growing use of groundwater is not a viable long-term alternative for commercial farms to mitigate water-related conflicts. The many new boreholes currently in use provide reason to worry, as the interactions between the various aquifers and river replenishment are unknown. Thus, their excessive use could have potentially devastating consequences in the long term. In a wider context, it is not sensible if the safeguarding of one natural water source occurs through the exploitation of another. In contrast, a sustainable solution to lessen the pressure on rivers has been the harvesting of rainwater from greenhouse rooftops. Hence, these various strategies and alternatives, in addition to the collaboration with other water users through the respective Water Resource User Associations, are therefore necessary measures to guarantee the future continuation of the commercial horticulture sector on the northwestern slopes of Mount Kenya.

As introduced in chapter 3.3, commercial horticulture companies are a subordinate category of agribusiness that, in turn, are elements and drivers of the agro-industrialization process. Kenya's horticulture industry as a whole has undergone the various processes illustrated in the four steps in the flow diagram in Figure 3.2 (Reardon et al. 2000, 197–198), following the steps to a very precise degree.

(1) Kenya has been subject to meta-trends such as income growth, urbanization, and market-oriented economic reforms (e.g. agricultural market liberalization following the Uruguay Round Agreements on Market Liberalization, see chapter 9.2.1), and the rise of modern technology (e.g. sells via internet).
(2) The changes in the global agrifood economy led to an opening of the Kenyan domestic agrifood markets to international competition accompanied by reduced state regulations following independence, general globalization, and new contractual arrangements between firms and farms.

These first two, broader patterns show that agro-industrialization is both a response to and an agent of globalization (Reardon et al. 2000, 197–198) and they unavoidably influence the still evolving agroindustry in Kenya.

(3) Typically, this influence shows in an increase in the average size of producing and processing companies, while smaller, traditional farms do not manage to reap available economies of scale. This process closely links to agricultural 'multinationalization' where foreign control over domestic agricultural firms increases. Product composition shifts towards those subsectors in which Kenya has a comparative advantage, e.g. horticultural products in general. This is complemented by an increase the value-added share of processing and distribution, as it is the case in the study area with Hybrid-Teas roses, for example.
(4) All these changes influence various 'development indicators'; they may all fuel growth in output and income per capita. However, the aggregate net gains hide distinct winner and losers, which often result from the ex-ante availability of access to infrastructure, as well as the spatial and sectoral distribution of the poor, the nature of the particular technologies introduced, and the indirect effects created by overall economic growth on the social and environmental dimensions.

Accordingly, the commercial horticulture sector northwest of Mount Kenya shows the typical characteristics of agribusiness activities in a developing country. Further research focusing on the farms' surrounding communities, their population, and the changes to their livelihood experienced through this agro-industrialization is advised in order to fully evaluate these impacts.

Commercial horticulture northwest of Mount Kenya is a typical example for the systemic interactions of the three fields of sustainability, namely economic, sociocultural, and ecological. However, sustainable development is a gradual process, due to the need to balance positive changes in values linked to one of the three dimensions of sustainability against negative fluctuations in values associated with another field of sustainability. This concept of 'weak sustainability' (Foy & Daly 1989 cited in Wiesmann 1997, 220) thus allows degrees of sustainability, rather than seeking to define sustainable development in absolute terms (Wiesmann 1997, 220). In this light, to evaluate the sustainability of the commercial horticulture sector in the study area in terms of the three dimensions of sustainability would require negotiation processes among various stakeholders, including some outside of the studied sector, to define the scales of values. This was beyond the scope of the study and was consciously left out. The intense focus of the study on the actor-category of commercial horticulturists does not allow concluding statements about the overall sustainability of the actor's activities. However, in a more general approach, some considerations about the three dimensions of sustainability (economic, sociocultural, and ecological) are discussed below. As the sociocultural dimension was not directly investigated, any social aspects are integrated together with economic aspects into a socioeconomic dimension.

- *Socioeconomic sustainability:* The commercial horticulture sector in the study area contributes significantly to the local economic development by providing employment to over 12,000 people. Furthermore, it is assumed that substantial economic side effects result from the resulting cash influx that flows from the employees into various businesses and shops in the towns and villages surrounding the farms. Moreover, many horticulture companies provide direct community support for projects and institutions, either monetary or in kind, which also has an important impact on the socioeconomic development of the region. However, there are some critical reflections regarding the economic sustainability of the sector, mainly the relative unilateral market orientation of vegetable farms towards the UK and the relative unilateral market orientation of flower farms towards the auction in the Netherlands. This raises various questions, such as, what will happen if these supermarkets in the UK decide to source their produce from elsewhere? What will happen, however unlikely, if the auction in the Netherlands crashes? What will happen if Kenya loses beneficial access to European markets as it does now with the Economic Partnership Agreements (EPAs)? Will the largest companies transplant their production to Tanzania or Ethiopia, which are both rising stars in the horticulture business but significantly poorer and thus more likely to retain their EPAs? Horticulture is a highly competitive business and the investigated sector appears to operate in a fragile economic and political environment.

- *Ecological sustainability:* This dimension is most strongly depreciated by the sector's water use during dry seasons. The demand for irrigation water during the dry season is very high, and operates in conflict with the climatic regime and low river flows. The opposing pattern of water demand and water supply creates an inherent ecological conflict. However, the pressure on river water can be reduced greatly through the development of water storage, which has been implemented by many farms, thus vastly ameliorating the situation since 2003. Nonetheless, farms remain that have no water storage or insufficient capacity to bridge them over the complete dry season. Thus, unless the demand for irrigation water decreases or water storage capacity increases even further, this ecological conflict will persist. The ecological sustainability of the commercial horticulture industry in the study area is further pressured by the farming activities themselves, such as the extensive use of fertilizer and various chemicals (pesticides, fungicides, and more), which affect water quality to an unknown degree. Furthermore, the impact of horticulture farming on the soils in the study area demands further research.

Thus, the presented empirical findings of the research effectively emphasize that in practice, sustainability is difficult to attain in all three dimensions. In addition, the involvement of the commercial horticulture sector in the study area reveals the systemic interactions of the three dimensions of sustainable development. It becomes most evident in the interplay between economic profits and the intensive use of natural resources at the expense of economic goals. Furthermore, the sustainable use of river water resources in the study area, or the implementation of water storage facilities (and access to groundwater), has become a crucial condition of the economic sustainability of commercial horticulture. If it were not for the increased implementation of water storage and groundwater availability, commercial horticulture today would not be possible to its current extent.

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Appendixes

- **Appendix I:** List of Companies and Farms
- **Appendix II:** Daily Water Use per Farm
- **Appendix III:** Daily Water Use per Hectare
- **Appendix IV:** Storage Capacity per Farm
- **Appendix V:** River Water Abstraction per Farm
- **Appendix VI:** Water Abstraction per River
- **Appendix VII:** Transformation of the Area under Horticulture and Water Sources of the Farms Persisting Since the First Study
- **Appendix VIII:** Commercial Horticulture Farms and Their Storage Capacity and Borehole Yields
- **Appendix IX:** Interview Guide for Interviews with Persons in Charge of Medium- and Large-Scale Horticulture Companies

Appendix I: List of Companies and Farms

2003

Companies in alphabetical order

Name of company	Type of company	Location (Name of farm and closest settlement)
Batian Flowers Ltd.*	E	Ol Donyo Farm, Timau
Cinnabar Green Ltd.	E	Borana Ranch, Ngare Ndare
Chestnut Farm	O	Chestnut Farm, Naro Moru
Countrywide Connection Ltd.	E	Kangaita Farm, Nanyuki
East African Growers Ltd.	E	Disa Farm, Timau
Elburgit Enterprise Ltd.	O	Turi Farm, Naro Moru
Everest Enterprises Ltd.	E	Chulu Farm, Timau
Homegrown (K) Ltd.	E	Timau and Ngushishi
Kentrout (1972) Ltd.	O	Kentrout Farm, Timau
Kisima Farm Ltd.	E	Kisima Farm, Timau
Kitawi Farm Ltd. (Vegpro [K] Ltd.)	E	Kitawi Farm, Lamuria
Likii River Farm Ltd. (Vegpro [K] Ltd.)	E	Likii River Farm, Nanyuki
Lobelia Farms Ltd.	E	Protea and Lobelia Farm, Ngushishi
Misty Highland Farm Ltd.	O	Misty Highland Farm, Naro Moru
Mr. and Mrs. Bill	O	Mackinder Farm, Timau
Mr. Daniel K. Tigiti	O	Tigiti Farm, Naro Moru
Mwarania Farm	O	Mwarania Farm, Timau
Northern Frontier Ventures	O	Lewa Downs
Tambuzi Ltd.	E and O	Tambuzi (Burguret) Farm, Burguret
Teleswani Ltd.	O	Teleswani Farm, Timau
Timau Gardens Ltd.	O	Timau Garden Farm, Ngushishi
Vitacress (K) Ltd.	E	Lolomarik Farm, Timau
Wangu Embori Investment Company	O	Embori Farm, Timau
Zwadi Irrigation Ltd.	O	Segera Ranch, Naro Moru

Farms according to their size

Code of company or farm	Type of company or farm	Category (area under horticulture)	Area under horticulture [ha]	Major crop category
C16/E6	E	l-s	190	V
C17.5	E	l-s	84	V
C17.4	E	l-s	77	V
C17.1	E	l-s	68	V and F
C17.3	E	l-s	62	V
C17.6	E	l-s	62	V
C4	O	l-s	57.5	V
C22	E	l-s	48	f
C24	E	l-s	45	V
C17.2	E	l-s	44	V
C5	E	l-s	40	V
C18	E	l-s	39	F and V
C21	O	l-s	39	V
C23	O	l-s	36	V
C12	O	l-s	30	V
C1	E	l-s	25	F
C20	O	l-s	25	V
C10	O	l-s	16	V
C25	O	l-s	15	V
C11	O	l-s	14	V
C19	O	l-s	13	V
C3	E and O	l-s	12	F
C13	E	l-s	10	V
C9	O	l-s	10	V
C8	E	m-s	7	F
C15	O	m-s	6	V and F
C7	E	m-s	5	F and V
C2	O	m-s	5	V

Legend: * =no interview data; E = exporter; O = outgrower; L = local market; l-s = large-scale; m-s = medium-scale; V = vegetables; F = flowers; f = fruit; H = herbs

2013

Companies in alphabetical order

Name of Company	Type of company	Location (Name of farm and closest settelment)
AAA Growers	E	Turi Farm and Chestnut Farm, Naro Moru
Afriorganic Kenya Ltd	E and O	Ngarendare Farm, Ngare Ndare
Batian Flowers Ltd.*	E	Ol Donyo Farm, Timau
Bemack Farm Ltd.	O	Bemack Farm, Timau
Bloomingdale Roses Kenya Ltd.	E	Bloomingdale Roses, Timau
Cinnabar Green Ltd.	E and L	Carrissa Farm, Naro Moru
Colour Crops Ltd.	E	Colour Crops, Nanyuki
Countrywide Connection Ltd. &	E	Kangaita Farm, Nanyuki
Equinox Horticulture Ltd.	E	Turaco Farm, Nanyuki
Everest Enterprise Ltd.	E	Chulu Farm, Timau
Finlays	E	Ibis Farm and Suroji Farm, Timau and Ngushishi
Greenlands Agroproducers Ltd.	E	Pioneer Farm and Nanyuki Ranch, Nanyuki
Jikaze Farm	L	Jikaze Farm
Kentrout 1972 Ltd.	O	Kentrout Farm, Timau
Kenya Horticultural Exporters	E	Ontilili River Farm, Jua Kali
Kisima Farm Ltd.	E	Kisima Farm, Timau
Koppert Cress 0.0 ° Ltd./ African	E	Jua Kali
Lewa Farm Ltd.	O	Lewa Farm, Timau
Lolomarik Ltd.	E	Marania Farm, Timau
P.J. Dave Group	E	Rising Sun, Timau
Sunland	E	Lobelia Farm and Protea Farm, Ngushishi
Sunripe (1976) Ltd.	E	Kandara Farm, Naro Moru
Tambuzi Ltd.	E and O	Tambuzi, Burguret
Teleswani Ltd.	O	Teleswani Farm, Timau
Timaflor	E	Tima 1 - 4, Timau
Timau Springs Farm	O	Timau Springs Farm, Timau
Uhuru Flowers Ltd.	E	Uhuru, Timau
Vegpro Group	E	Likii River Farm and Kongoni River Farm, Nanyuki and Umande
Vegpro Group*	E	Kitawi Farm, Lamuria
Wangu Embori Investment Company	0	Embori Farm, Timau

Farms according to their size

Code of Farm/Company	Type of company or farm	Category (area under horticulture)	Area under horticulture [ha]	Major crop category
E15.1	E	l-s	250	V and F
E24	E	l-s	162	V
E1	O	l-s	121.4	V
E17	E	l-s	86	F
E27.2	E	l-s	86	V and H
E19.1	E	l-s	57	V
E28	E	l-s	56.6	V and H
E27.1	E	l-s	56	V and H
E30	E	l-s	35	F
E14	E	l-s	32	F
E15.2	E	l-s	31	F
E21	O	l-s	25	V
E20	O	l-s	24.2	V
E12	E	l-s	23.5	F
E22.1	E	l-s	23	F
E13	E	l-s	22	F
E19.2	E	l-s	22	V
E22.2	E	l-s	21	F
E4	O	l-s	20.1	V
E11	E	l-s	20	F
E25	E and O	l-s	20	H
E16	E	l-s	18.5	F
E3	O	l-s	15	V and H
E7	E and O	l-s	15	F and H
E8	E	l-s	15	F
E10	E	l-s	15	F
E2	L	l-s	12.1	V
E6	E	l-s	10.1	H
E5.1	E	l-s	10	F
E5.2	E	l-s	9	F
E9	O	m-s	8	V
E18	E	l-s	10	F
E23	E and L	m-s	4.5	H
E26	E	m-s	4	V and f
E29	E	l-s	no data	V

Legend: * =no interview data; E = exporter; O = outgrower; L = local market; l-s = large-scale; m-s = medium-scale; V = vegetables; F = flowers; f = fruit; H = herbs

Appendix II: Daily Water Use per Farm and Water Sources Utilized

Farm Code	Water Sources	Irrigated Area [ha]	Mean Daily Water Use [m3/d]										Formulas and description of calculated values
			Sepcified in Interview [m³/d]			Specified in interview or calculated (Wemp) [m³/d]				Calculated [m³/d]			
			mean annual	dry season	rainy season	mean annual	**mean dry season**	**mean dry season [l/s]**	mean rainy season	mean annual	dry season	rainy season	
E1	Groundwater and Storage Water	121.4	No	No	No	**950**	**1617**	**18.7**	**0**	950	1617	0	Mean annual area under cultivation is based on two crop plantings per year with an average growing period of 16 weeks: (121.4*7*2*16)/365=74.5ha mean area under cultivation. Borehole capacity is 95m3/h times 10h of pumping euqals 950m3. During dry season a dam (60'000m3) provides additional water. Assuming it is used druing the 90 days it should last: 60'000m3/90d=666.666m3/d + 950m3/d = during dry season.
E2	River	12.1	No	No	No	**No data**	**240**	**2.8**	**No data**	No	240	No	Pumping capacity is 30 m3/h times 8h of pumping/d (interview specification) during dry season equals 240m3/d of water during dry season.
E3	River and Groundwater	15	No	No	No	**621**	**750**	**8.7**	**365**	No	750	No	Borehole yield is 40 m3/h, they pump it for 3 hours every 2nd day: 40m3/h*3*3.5 = 450m3 = 60%, therefeor 100% = 750 m3. Means (Wemp) per [d] for mean annual and rainy season calculated from the respective seasons values (spec. or calc.) of all the vegetable companies (mean annual: n=12; rainy season: n=9).
E4	River and Storage Water	20.1	No	1250	960	**1103**	**1250**	**14.5**	**960**	1034	No	No	Mean annual value calculated based on two dry seasons per year, each à 90 days: (185d*48m3/ha*d)+(180d*62m3/ha*d)=20040m3/365d=54.90m3/ha *20.1ha=1103.49m3/d. Dry and rainy season's daily water use are given.
E5.1	River and Groundwater	10	No	No	No	**366**	**427**	**4.9**	**290**	349	403	280	Means (Wemp) per [d] and [ha] of all the flower farms with either specified or calculated values multiplied by the respective season's area under cultivation (see appendixes III and IV)
E5.2	Groundwater and Storage Water	9	No	No	No	**330**	**385**	**4.5**	**261**	314	362	252	Means (Wemp) per [d] and [ha] of all the flower farms with either specified or calculated values multiplied by the respective season's area under cultivation (see appendixes III and IV)
E6	Storage Water	10.1	No	No	No	**353**	**404**	**4.7**	**303**	353	404	303	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E7	Storage Water	15	No	900	No	**711**	**900**	**10.4**	**600**	711	No	600	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E8	Groundwater and Storage Water	15	No	600	300	**448**	**600**	**6.9**	**300**	448	680	300	Mean annual value calculated based on two dry seasons per year, each à 90 days: ((185*20)+(180*40))=10900/365= 29.86m3/ha*15=447.9.
E9	River	8	No	No	No	**240**	**240**	**2.8**	**212**	240	No	No	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E10	Groundwater	15	No	No	No	**187**	**225**	**2.6**	**150**	187	225	150	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV). Mean annual calculated based on two dry seasons per year, each à 90 days: ((185*10)+(180*15))=45500/365= 12.46m3/ha*15ha=186.9
E11	Groundwater and Storage Water	20	No	800	600	**699**	**800**	**9.3**	**600**	699	No	No	Mean annual calculated based on two dry seasons per year, each à 90 days: ((185*30)+(180*40))=12750/365=34.93*20=698.6.
E12	River, Groundwater , and Storage Water	23.5	904	No	No	**904**	**1003**	**11.6**	**571**	734	1003	571	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E13	Groundwater	22	No	1300	1000	**1097**	**1300**	**15.0**	**1000**	1097	No	No	Mean annual (calc.) based on two dry seasons per year, each à 90 days: ((185*40)+(180*60))=18200/365=49.86*22=1096.92
E14	River, Groundwater , and Storage Water	32	1150	1500	800	**1150**	**1500**	**17.4**	**800**	1600	2080	1120	Values specified during interview. These values are lower than Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendices (daily water use per ha) & (storage capacity)). However, the values per [d] and [ha] include water used in the packhouse, hence the total values given per [d] are deemed reliable for irrigation purposes only.

E15.1	River and Storage Water	250	No	10000	4000	**8049**	**10000**	**115.7**	**4000**	8049	No	No	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendices (daily water use per ha) & (storage capacity)).
E15.2	River and Storage Water	31	No	No	No	**1550**	**1550**	**17.9**	**1550**	1550	1550	1550	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendices (daily water use per ha) & (storage capacity)).
E16	River and Storage Water	18.5	430	No	No	**430**	**791**	**9.2**	**536**	No	791	536	Total water use given in interview for the whole farm is 500 m3 of which 430 m3 are used for floriculture. Value is low compared to own calculations, still specified value is taken as true. Means (Wemp) for dry and rainy season per [d] of the respective season's multiplied by the season's respective area under horticulture (see appendices (daily water use per ha) & (storage capacity)).
E17	River, Groundwater, and Storage Water	86	2400	3200	1600	**2400**	**3200**	**37.0**	**1600**	No	No	No	All values specified during interview.
E18	Groundwater	7	No	No	No	**192**	**210**	**2.4**	**175**	192	210	175	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV) Mean annual calculated based on two dry season à each 90 days:((185*25)+(180*30))=10025/365=27.46m3/ha*7ha=192.22m3
E19.1	Groundwater	57	No	No	No	**3420**	**5130**	**59.4**	**1710**	3420	5130	1710	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E19.2	No data	22	No	No	No	**1320**	**1980**	**22.9**	**660**	1320	1980	660	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendices (daily water use per ha) & (storage capacity))
E20	Groundwater	24.2	No	No	No	**1192**	**1936**	**22.4**	**No data**	1192	1936	No	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E21	Groundwater and Storage Water	25	No	No	260	**903**	**761**	**8.8**	**503**	903	785	503	Means (Wemp) per [d] and [ha] of all the vegetable farms with either specified or calculated values multiplied by the respective season's area under cultivation (see appendixes III and IV)
E22.1	River and Storage Water	23	No	No	No	**805**	**926**	**10.7**	**644**	805	926	644	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E22.2	Groundwater and Storage Water	21	No	No	No	**735**	**845**	**9.8**	**588**	735	845	588	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E23	Groundwater	4.5	No	No	No	**51**	**51**	**0.6**	**No data**	51	51	No	80m3/ha*7d = 11.4m3/ha*d (see appendixes III and IV)
E24	River and Storage Water	162	7000	No	No	**7000**	**9720**	**112.5**	**4473**	No	9720	4473	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E25	River	20	No	900	30	**410**	**900**	**10.4**	**30**	410	No	No	Mean annual (Wemp) based on two dry seasons per year, each à 90 days: (0.666*20) + (0.333*1) = 13.653ha*30m3=409.59
E26	River	4	No	No	No	**143**	**101**	**1.2**	**106**	143	101	106	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E27.1	River, Groundwater, and Storage Water	56	No	2000	No	**2446**	**2000**	**23.1**	**1363**	No	1839	No	Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9) and multiplied by the respective season's area under cultivation.
E27.2	River and Storage Water	86	No	3000	No	**3757**	**3000**	**34.7**	**2093**	No	3000	No	Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9) and multiplied by the respective season's area under cultivation.
E28	Groundwater	56.6	No	900	No	**2345**	**2547**	**29.5**	**1379**	2345	2345	1379	Means (Wemp) per [d] and [ha] of the respective season's multiplied by the season's respective area under horticulture (see appendixes III and IV)
E29	No data	No data	No data	No data	No data	**No data**	**No data**	**No data**	**No data**	No data	No data	No data	No interview data
E30	No data	35	No data	No data	No data	**No data**	**No data**	**No data**	**No data**	No data	No data	No data	No interview data
							Total sector's dry season water use [m³/d]	**Total sector's dry season water use [l/s]**					
							57289	**663.07**					
							n=33	**n=33**					

Appendix III: Daily Water Use per Hectare and Water Sources Utilized

Farm Code	Water Sources	Irrigated Area [ha]	Mean Daily Water Use [m³/d*ha] per Farm									Formulas and description of calculated values
			Sepcified in Interview [m³/d]			Specified in interview or calculated (Wemp) [m³/d*ha]			Calculated [m³/d]			
			mean annual	dry season	rainy season	mean annual	**mean dry season**	mean rainy season	mean annual	dry season	rainy season	
E1	Groundwater and Storage Water	121.4	No	No	0	**13**	**13**	**0**	13	13	No	Respective's season's daily water use (Wemp) divided by the respective's season's area under horticulture (see appendixes II and IV)
E2	River	12.1	No	No	No	**No data**	**20**	**No data**	No	20	No	Dry season's daily water use (Wemp) divided by dry season's area under horticulture (see appendixes II and IV)
E3	River and Groundwater	15	No	No	No	**48**	**50**	**26**	48	50	26	Dry season's daily water use (Wemp) divided by dry season's area under horticulture (see appendixes II and IV). Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; rainy season: n=9)
E4	River and Storage Water	20.1	No	No	No	**55**	**62**	**48**	51	62	48	Respective's season's daily water use (Wemp) divided by the respective's season's area under horticulture (see appendixes II and IV). Mean annual water sue per [ha] calculated based on two rainy seasons à 90 days each: (185*48)+(180*62)=20040/365=54.90m3/ha
E5.1	River and Groundwater	10	No	No	No	**37**	**43**	**29**	35	40	28	Means (Wemp) per [ha] of the respective season calculated from the mean value of the respective season of all the other flower farms with either specified or calculated values (n=13).
E5.2	Groundwater and Storage Water	9	No	No	No	**37**	**43**	**29**	35	40	28	Means (Wemp) per [ha] of the respective season calculated from the mean value of the respective season of all the other flower farms with either specified or calculated values (n=13).
E6	Storage Water	10.1	No	40	30	**35**	**40**	**30**	35	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: (185*30)+(180*40)=12750/365=34.93m3/ha
E7	Storage Water	15	No	55	40	**47**	**55**	**40**	47	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: ((185*40) + (180*55))=17300m3/365=47.39m3/ha
E8	Groundwater and Storage Water	15	No	40	20	**30**	**40**	**20**	30	No	No	Pump the BH for max. 8 h (dry season). Dry season daily water use can be calculated as followed: if the BH is pumped for 8h, then it's 8 x 40m3/h = 320 = 47%, so 100% = 680m3,divided by 15 ha = 45m3/ha/d --> Given in the interview are 2 - 4l/m2, this equals to 20 - 40m3/ha. Mean annual ((185*20)+(180*40))=10900/365= 29.86m3/ha.Wet season daily water use is calculated (300/15=20)
E9	River	8	30	No	No	**30**	**30**	**26**	No	30	26	Specified mean annual water use per [d] is assumed to be the same during dry season. Mean rainy season water use (Wemp) per [ha] and [d] calculated from the mean value of the respective season of all the other vegetable farms with either specified or calculated values (n=9)
E10	Groundwater	15	No	15	10	**12**	**15**	**10**	12	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: ((185d*10m3/h)+(180d*15m3/h))=45500m3 per ha/365d= 12.46m3/ha.
E11	Groundwater and Storage Water	20	No	40	30	**35**	**40**	**30**	35	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: ((185d*30m3)+(180d*40m3))=12750m3 per ha/365d=34.93m3/ha
E12	River, Groundwater, and Storage Water	23.5	31	43	24	**31**	**43**	**24**	No	No	No	All values specified during the interview.
E13	Groundwater	22	No	60	40	**50**	**60**	**40**	50	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: ((185d*40m3)+(180d*60m3))=18200m3/365s=49.86m3/d.
E14	River, Groundwater, and Storage Water	32	50	65	35	**50**	**65**	**35**	No	No	No	50m3/ha*d, minus 20-30% (10-15m3) when overcast, plus 20-30% (10-15m3) when dry, hot, windy, dusty. 50m3/ha*d include water used in packhouse and to create artificical humidty.
E15.1	River and Storage Water	250	No	No	No	**38**	**45**	**21**	38	45	21	From June to September, the area under cultivation for Lilies drops from 50ha to 11ha, in the same period the area under cultivation for vegetables increases by 39ha: Lilies mean annual area under cultivation is calculated as follows: (0.666*50ha) + (0.333*11ha) = 37 ha; Vegetables mean annual area under cultivation is calculated as follows: (0.666*130ha) + (0.333*169ha) = 142.857ha, Herbs drop 70% during European summer (june-sep) to 12ha, the mean annual area is calculated as follows: (0.666*40)+(0.333*12)=30.636ha. Hence, the mean annual area under cultivation = 37+142.857+30.636=210.493ha. Water use for Herbs is assumed to be the same as for vegetables because of interview indications. Hence: 173.493ha*40m3 = 6939.72m3; 37ha*30m3=1110m3 -> (1110+6939.72)/210.493ha = 38.24m3/ha. Mean dry season and mean rainy season values are calculated by dividing the daily water use per farm by the respective season's area under cultivation (see appendixes II and IV).
E15.2	River and Storage Water	31	50	50	50	**50**	**50**	**50**	No	No	No	All values specified during the interview.

E16	River and Storage Water	18.5	30	No	No	**30**	**43**	**29**	No	43	29	40% (7.4ha) of production is under hydroponics which need 50m3/ha*d but 30% (15m3/ha*d) of that water is recycled. Roses in soil need about 25m3/ha*d. Hence, 11.1ha*25m3/ha =277.5m3 and 7.4ha*35m3/ha = 259m3. 259+277.5=536.5m3/18.5 =29m3 on average. Means (Wemp) For dry and rainy season per [ha] and [d] of the respective season calculated from the mean value of the respective season of all the other flower farms with either specified or calculated values (n=13).
E17	River, Groundwater, and Storage Water	86	30	No	No	**30**	**37**	**19**	No	37	19	Respective's season's daily water use (Wemp) divided by the respective's season's area under horticulture (see appendixes II and IV).
E18	Groundwater	7	No	30	25	**27**	**30**	**25**	27	No	No	Mean annual daily water use per [ha] based on two dry seasons à each 90 days: ((185*25)+(180*30))=10025/365=27.46m3/ha
E19.1	Groundwater	57	60	90	30	**60**	**90**	**30**	No	No	No	All values specified during the interview.
E19.2	No data	22	60	90	30	**60**	**90**	**30**	No	No	No	Since E19.1 and E19.2 are from the same company, lie close together and produce the same, the values on water use from 19.1 are applied to 19.2.
E20	Groundwater	24.2	80	80	No	**80**	**80**	**26**	No	No	26	Mean annual water use per [d] and [ha] is assumed to be the same during dry season. Mean rainy season water use (Wemp) per [ha] and [d] calculated from the mean value of the respective season of all the other vegetable farms with either specified or calculated values (n=9)
E21	Groundwater and Storage Water	25	No	No	No	**48**	**51**	**26**	48	51	26	Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9)
E22.1	River and Storage	23	35	40	28	**35**	**40**	**28**	No	No	No	All values specified during the interview.
E22.2	Groundwater and Storage Water	21	35	40	28	**35**	**40**	**28**	No	No	No	All values specified during the interview.
E23	Groundwater	4.5	11	11	No	**11**	**11**	**No data**	No	No	No	80m3/ha/week (indicated in interview) is assumed to be the same in dry season.
E24	River and Storage	162	No	60	30	**47**	**60**	**30**	47	No	No	Mean annual daily water use per farm divided by mean annual [ha] under cultivation.
E25	River	20	No	30	30	**30**	**30**	**30**	30	No	No	Mean annual daily water use (Wemp) divided by mean annual area under horticulture (see appendixes II and IV).
E26	River	4	No	No	No	**48**	**51**	**26**	48	51	26	Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9)
E27.1	River, Groundwater, and Storage Water	56	No	No	No	**48**	**36**	**26**	48	36	26	Dry season's daily water use (Wemp) divided by dry season's area under horticulture (see appendices (water use per farm) & (storage capacity)). Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9)
E27.2	River and Storage Water	86	No	No	No	**48**	**38**	**26**	48	38	26	Dry season's daily water use (Wemp) divided by dry season's area under horticulture (see appendices (water use per farm) & (storage capacity)). Means (Wemp) per [ha] for mean annual and rainy season calculated from the means of the respective season of all the other vegetable farms with either specified or calculated values (mean annual: n=12; dry season: n=15; rainy season: n=9)
E28	Groundwater	56.6	45	No	No	**45**	**45**	**26**	No	45	26	Mean annual water use per [d] and [ha] is assumed to be the same during dry season. Mean rainy season water use (Wemp) per [ha] and [d] calculated from the mean value of the respective season of all the other vegetable farms with either specified or calculated values (n=9)
E29	no interview data	No data	No data	No data	No data	**No data**	**No data**	**No data**	No data	No data	No data	No interview data
E30	no interview data	35	No data	No data	No data	**No data**	**No data**	**No data**	No data	No data	No data	No interview data
			Mean [m³/d*ha]	Mean [m³/d*ha]	Mean [m³/d*ha]	mean annual (Wemp) [m³/d*ha]	**mean dry season (Wemp) [m³/d*ha]**	mean rainy season (Wemp) [m³/d*ha]	Mean [m³/d*ha]	Mean [m³/d*ha]	Mean [m³/d*ha]	
			42	49	28	40	45	28	38	40	27	
			n=13	n=18	n=17	n=22	**n=26**	n=19	n=19	n=15	n=14	
			Mean [l/s*ha]	Mean [l/s*ha]	Mean [l/s*ha]	mean annual (Wemp) [l/s*ha]	**mean dry season (Wemp) [l/s*ha]**	mean rainy season (Wemp) [l/s*ha]	Mean [l/s*ha]	Mean [l/s*ha]	Mean [l/s*ha]	
			1.22	1.41	0.82	0.46	**0.52**	0.32	1.10	1.16	0.79	

Appendix IV: Storage Capacity per Farm

Farm Code	Water Sources	Total Farm Area	Total Area under Horticultural Production	Dry Season Area under Horticultural Cultivation	Mean Annual Area under Horticultural Cultivation	Wet Season Area under Horticultural Cultivation	Storage Capacity for Dry Season Irrigation	Duration of Storage specified	Description of dry season adjustments in irrigation and/or cultivation (interview specifications)	Assumptions and description of calculations
		[ha]	[ha]	[ha]	[ha]	[ha]	[m3]	[d]		
E1	Groundwater and Storage Water	4249	121.4	121.4	74.5	no data	60,000	no data	Production is driven by European market demand which is highest during European winter which concides with the Kenian dry season.	Mean annual area is based on two crop plantings per year with an average growing period of 16 weeks: (121.4*7*2*16)/365 = 74.5ha under cultivation.
E2	River	24.7	12.1	12.1	7.425	no data	no	no	Does not export anymore, but only sells on local market. Pumps 30m^3/h for 8h/d from the river.	Mean annual area under cultivation based on two crop plantings per year: (12.1*7*2*16)/365=7.425ha
E3	River and Groundwater	50	15	15	13.8	13.8	no	no		Mean area under cultivation is calculated on the bases of three crop plantings/year with an average growing period of 16 weeks: (15*7*3*16)/365=13.8 ha. Mean annual area under cultivation is aassumed to be the same as teh area under cultivation during rainy season.
E4	River and Storage Water	242.8	20.1	20.1	20.1	20.1	150,000	no data	Given during interview	
E5.1	River and Groundwater	no data	10	10	10	10	no	no	No variation of the area under floriculture troughout the year	
E5.2	Groundwater and Storage Water	no data	9	9	9	9	no data	no data	No variation of the area under floriculture troughout the year	
E6	Storage Water	60.7	10.1	10.1	10.1	10.1	30,000	no data	No variation of the area under horticultrue troughout the year	
E7	Storage Water	64	15	15	10	5	150,000	90	Summerflowers and herbs are not irrigated during rainy season which amounts to approximatley 15m^3/d less irrigation water needed during that time.	
E8	Groundwater and Storage Water	75	15	15	15	15	53,000	no data	Pump the borehole for max. 8 h during dry season.	
E9	River	56.6	8	8	8	8	400	no data	Need 30m^3 of water for half a hectare every second day.	
E10	Groundwater	20	15	15	15	15	no	no	Roses are grown outdoors not within greenhouses.	
E11	Groundwater and Storage Water	4500	20	20	20	20	232,000	no data	Increased water demand during dry season in order top create more humid microclimatic conditions.	
E12	River, Groundwater, and Storage Water	27	23.5	23.5	23.5	23.5	121,000	>100	No variation of the area under floriculture troughout the year	
E13	Groundwater	40	22	22	22	22	no	no	Water use figures include post-harvest water demand. 26000m^3/month stems from the boreholes.	
E14	River, Groundwater, and Storage Water	35	32	32	32	32	162,000	90-120	50m3/ha/d include humidity, packhouse, etc. As a rule of thumb one can substract -20-30% (10-15m^3) water use when it's overcast, and add +20-30% (10-15m^3) water use when it's dry, hot, windy, dusty.	the 50m3/ha/d include humidity, packhouse, etc. -20-30% (10-15m3) when overcast, +20-30% (10-15m3) when dry, hot, windy, dusty.
E15.1	River and Storage Water	340	250	220	210.493	192	930,000	>100	Vegetables need 40m^3/ha and Lilies 30m^3/ha on average. From June to September, the area under lily cultivation drops from 50ha to 11ha, in the same period the area under cultivation for vegetables increases by 39ha. Herbs drop 70% during European summer (June-September) to 12ha.	Calculation procedures for mean area under cultivation according to different crops: Lillies = (0.666*50ha) + (0.333*11ha) = 37 ha; Vegetables = (0.666*130ha) + (0.333*169ha) = 142.857ha; Herbs:(0.666*40)+(0.333*12)=30.636ha. Water use for Herbs is assumed to be the same as for vegetables because of interview indications. Hence: 142.857ha+30.636ha =173.493ha*40m^3 = 6939.72m^3/173.493ha + 37ha*30m^3=1110m^3/37ha -> (1110+6939.72)/210.493ha = 38.24m^3/ha. Mean dry: (10000m^3/ha/220ha=45.45m^3); Mean wet: (4000m^3/ha/192ha=20.8m^3)
E15.2	River and Storage Water	45	31	31	31	31	126,000	no data	Borehole is only used for packhouse.	
E16	River and Storage Water	4000	18.5	18.5	18.5	18.5	150,000	no data	Has 40% (7.4ha) of production under hydroponics: roses in soil need about 25m3/ha/d, hydroponics need 50m3/ha/d but 30% (15m3/ha) of that water is recycled. Total water use specified in interview for the whole farm is 500 m3 including drinking water.	Hence, 11.1ha*25m3/ha =277.5m3 and 7.4ha*35m3/ha = 259m3. 259+277.5=536.5m3/18.5 =29m3 on average.
E17	River, Groundwater, and Storage Water	526	86	86	86	86	320,000	100	No variation of the area under floriculture troughout the year	
E18	Groundwater	48.5	7	7	7	7	in constructio n	no	BH1: 30m3/h, BH2: 20m3/h, BH3: 25m3/h -> for 6h/d = 450m3/d; Dam in construction, not in use yet.	At the time of the interview only 7 ha were planted and 1 ha was under production, but farm was established shortly before in 2013. Aim is to have 30 ha under horticultural production.
E19.1	Groundwater	71	57	57	57	57	no	no		
E19.2	No data	57	22	22	22	22	no data	no data	No data	Since E19.1 and E19.2 are from the same company, lie close together and produce the same, the values on water use from 19.1 are applied to 19.2.
E20	Groundwater	40.4	24.2	24.2	14.9	no data	no	no	40m^3/0.5ha per day	
E21	Groundwater and Storage Water	50	25	15	19	19	no data	no data	Cultivates only 19ha of the 25ha at once (6 ha are under fallow) and has only 15ha cultivation in dry season.	

E22.1	River and Storage Water	92.5	23	23	23	23	180,000	210	On average uses 30-35m3/ha/d with +15% during dry season and -20% during rainy season.	
E22.2	Groundwater and Storage Water	102	21	21	21	21	160,000	180	On average uses 30-35m3/ha/d with +15% during dry season and -20% during rainy season.	
E23	Groundwater	88	4.5	4.5	4.5	4.5	no	no	80m^3/ha per week	
E24	River and Storage Water	250	162	162	149.1	149.1	1,158,000	5 months		Mean annual area under cultivation based on 3 crop plantings a year with an average growing period of 16 weeks: (162*7*3*16)/365=149.1ha
E25	River	40	20	20	13.653	1	no	no	During rainy season only 1 ha is irrigated in a greenhous, the rest is rainfed	
E26	River	20.2	4	2	3.01	4	no	no	During dry season the cultivation of sugar snaps and snow peas drops 50%.	
E27.1	River, Groundwater, and Storage Water	61.9	56	56	51.5	39.2	90,000	60-90	⅓ less production during UK summer (= local rainy season)	Mean annual area under cultivation is based on 3 crop plantings per year with an average growing period of 16 weeks: (56*7*3*16)/365= 51.5 ha
E27.2	River and Storage Water	140.4	86	86	79.1	60.2	250,000	90	⅓ less production during UK summer (= local rainy season)	Mean annual area under cultivation is based on 3 crop plantings per year with an average growing period of 16 weeks: (86*7*3*16)/365= 79.1ha*48.23 ha.
E28	Groundwater	72.8	56.6	56.6	52.1	no data	no	no	Pump the borehole for 8 h during dry season.	Mean annual area under cultivation is based on 3 crop plantings per year with an average growing period of 8 weeks: (56.6*7*3*16)/365=52.1 ha
E29	No data	55	45	45	45	no data	No data	No data	No data	no interview data, farm size was taken from Schuler 2004
E30	No data	56.6	35	35	35	35	No data	No data	No data	no interview data, 56.6 ha are leased out to them from E31 (interview indication), official homepage of E30 indicates that 35 ha of these 56.6 produce roses.
		Total Sector Area [ha]	Total Sector Area [ha]	Total Sector Area [ha]	Total Sector Area [ha]	Total Sector Area [ha]	Total Water Storage Capacity of the Sector [m^3]			
		15602.1	1382	1340	1233.281	973	4,322,400			
		n=33	n=35	n=35	n=35	n=30	n=30			
			Mean Area per Farm [ha]	Mean Area per Farm [ha]	Mean Area per Farm [ha]	Mean Area per Farm [ha]	Stored water storage availability per day during dry season (90d) [m^3/d]			
			39	38	35	32	48,026			
							Stored water storage availability per day during dry season (90d) [l/s]			
							555.86			

Appendix V: River Water Abstractions per Farm

Farm Code	Water Sources	Name of River	Mean dry season water use per day, farm and hectare [m³/d]		Mean dry season water use per day and farm [l/s]		Area under horticulture [ha]	Area under horticulture during dry season [ha]	Availability of storage water per day during dry season [l/s]	Mean dry season groundwater use per day [l/s]	Mean dry season river water abstraction per farm [l/s]	
			Specified or calculated (Wemp)	Demand based estimate (Wdem)	Specified or calculated (Wemp)	Demand based estimate (Wdem)					Specified or calculated (Wemp)	Demand based estimate (Wdem)
E1	Groundwater and Storage Water	no river	13	57.81	18.70	81.23	121.4	121.4	7.72	10.98	0.00	62.53
E2	River	Ewaso Ng'iro	20	57.12	2.78	8.00	12.1	12.1	no	no borehole	2.80	8.00
E3	River and Groundwater	Teleswani River	50	59.62	8.68	10.35	15	15	no	5.21	3.47	5.14
E4	River and Storage Water	Teleswani River	62	60.27	14.47	14.02	20.1	20.1	19.29	no borehole	0.00	0.00
E5.1	River and Groundwater	Ngusishi River	43	74.22	4.95	8.59	10	10	no	2.97	1.98	5.62
E5.2	Groundwater and Storage Water	no river	43	74.21	4.45	7.73	9	9	no data	2.67	1.78	5.06
E6	Storage Water	no	40	59.11	4.68	6.91	10.1	10.1	3.86	0.00	0.82	3.05
E7	Storage Water	Burguret River	55	60.13	10.42	10.44	15	15	19.29	0.00	0.00	0.00
E8	Groundwater and Storage Water	no river	40	59.16	6.94	10.27	15	15	6.82	3.26	0.00	0.19
E9	River	Teleswani River	30	66.10	2.78	6.12	8	8	0.05	no borehole	2.73	6.07
E10	Groundwater	no river	15	57.89	2.60	10.05	15	15	no	2.60	0.00	7.46
E11	Groundwater and Storage Water	Ngusishi River	40	59.14	9.26	13.69	20	20	29.84	4.63	0.00	0.00
E12	River, Groundwater, and Storage Water	Ontilili	43	63.53	11.61	17.28	23.5	23.5	15.56	0.49	0.00	1.23
E13	Groundwater	no	60	63.03	15.05	16.05	22	22	no	15.05	0.00	1.00
E14	River, Groundwater, and Storage Water	Likii River	65	58.54	17.40	21.68	32	32	20.83	0.24	0.00	0.67
E15.1	River and Storage Water	Kongoni (35%), Ontilili (35%), Sirimon (10%)	45	59.42	115.74	151.29	250	220	119.60	0.00	0.00	31.69
E15.2	River and Storage Water	Timau River	50	59.64	17.94	21.40	31	31	16.20	0.00	1.74	5.20
E16	River and Storage Water	Ngare Nyting River	43	65.71	9.15	14.07	18.5	18.5	19.29	0.00	0.00	0.00
E17	River, Groundwater, and Storage Water	Ngusishi River	37	79.47	37.04	79.10	86	86	41.15	14.81	0.00	23.13
E18	Groundwater	no river	30	58.63	2.43	4.75	7	7	no	2.43	0.00	2.32
E19.1	Groundwater	no river	90	66.15	59.38	43.64	57	57	no	59.38	0.00	0.00
E19.2	No data	no data	90	61.66	22.92	15.70	22	22	no data	no data	22.92	15.70
E20	Groundwater	no river	80	61.16	22.41	17.13	24.2	24.2	no	22.41	0.00	0.00
E21	Groundwater and Storage Water	no river	51	59.62	8.80	10.35	25	15	no data	no data	0.00	0.00
E22.1	River and Storage Water	Likii River	40	59.17	10.71	15.75	23	23	23.15	0.00	0.00	0.00
E22.2	Groundwater and Storage Water	no river	40	59.16	9.78	14.38	21	21	20.58	3.91	0.00	0.00
E23	Groundwater	Naro Moru River	11	58.37	0.59	3.04	4.5	4.5	no	0.59	0.00	2.45
E24	River and Storage Water	Timau River	60	58.34	112.50	109.39	162	162	148.92	no borehole	0.00	0.00
E25	River	Ngare Ndare river	30	59.40	10.42	13.75	20	20	no data	no data	10.42	13.75
E26	River	Burguret River	51	59.62	1.17	1.38	4	2	no data	no data	1.17	1.38
E27.1	River, Groundwater, and Storage Water	Burguret River	36	57.86	23.15	37.50	56	56	11.57	2.89	8.68	23.03
E27.2	River and Storage Water	Naro Moru River	38	57.84	34.72	57.57	86	86	32.15	0.00	2.57	25.42
E28	Groundwater	no river	45	70.65	29.48	46.28	56.6	56.6	no	29.48	0.00	16.09
E29	No data	no interview data	no interview data	no interview data	no interview data	no interview data	45	45	no interview data	no interview data	no data	no data
E30	No data	Ngusishi River	no interview data	no interview data	no interview data	no interview data	35	35	no interview data	no interview data	no data	no data

Appendix VI: River Water Abstractions per River

2003

Name of river	Number of riparian farms (n=28)	**Dry season water use of large scale horticulture farms along respective rivers) (incl. water from storage and boreholes) [l/s]:**		Cumulated storage capacity available per day during dry season on riparian farms [l/s]	Cumulated water contributed by Groundwater pumping [l/s]	**Dry season river water abstractions of farms along respective rivers [l/s]**	
		Total dry season water use of riparian farms (Wemp)	Total dry season water use of riparian farms (Wdem)			Total river water use of riparian farms (Wemp)	Total river water use of riparian farms (Wdem)
Ewaso Ng'rio	2	16.8	46.7	0.0	0.0	16.8	46.7
Naromoru (icl. Mwichuni)	2	40.6	33.8	25.7	0.0	14.9	8.1
Burguret	3	17.4	19.1	21.6	0.0	-4.2	-2.5
Likii	2	23.0	34.5	16.7	0.0	6.3	17.8
Ontulili and Sirimon	4	105.1	151.4	61.7	0.0	43.3	89.6
Teleswani (incl. Kongoni)	3	18.6	33.0	0.0	0.0	18.6	33.0
Ngusishi	4	82.6	144.5	25.9	37.2	19.5	81.4
Timau (incl. Kithaeni and Logiladu)	3	31.0	36.9	16.0	2.1	12.9	18.9
Ngare Nyting	2	5.3	14.2	2.1	0.0	3.2	12.1
Ngare Ndare	1	9.7	17.0	0.0	0.0	9.7	17.0

Total [m3/s]	Total [m3/s]	Total [m3/s]	Total [m3/s]	Total [m3/s]	Total [m3/s]
357.2	**567.1**	171	47	**145.2**	**324.5**
Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]
30861	**48998**	**14796**	**4015**	**12549**	**28040**

Mean dry season water quantity abstracted per river (Wemp) [l/s]	Mean dry season water quantity abstracted from river (Wdem) [l/s]
14.10	**32.20**

2013

Name of River	Number of Riparian Farms (n=24)	**Dry season water use of large scale horticulture farms along respective rivers) (incl. water from storage and boreholes) [l/s]:**		Cumulated storage capacity available per day during dry season on riparian farms [l/s]	Cumulated water contributed by Groundwater pumping [l/s]	**Dry season river water abstractions of farms along respective rivers [l/s]**	
		Total dry season water use of riparian farms (Wcalc. or W spec.)	Total dry season water use of riparian farms (Wdem)			Total river water use of riparian farms (Wcalc. or W spec.)	Total river water use of riparian farms (Wdem)
Ewaso Ng'rio	1	2.8	8.0	0.0	0.0	2.8	8.0
Naromoru (icl. Mwichuni)	2	353.0	60.6	322.0	0.6	2.6	27.9
Burguret	3	34.7	37.8	30.9	2.9	9.9	24.4
Likii	2	28.1	37.6	44.0	0.2	0.0	0.7
Ontulili and Sirimon	2	63.7	717.1	69.4	0.5	0.0	15.5
Teleswani (incl. Kongoni)	4	66.4	834.0	61.2	5.2	6.2	22.3
Ngusishi	4	51.2	101.4	71.0	22.4	2.0	28.8
Timau (incl. Kithaeni and Logiladu)	2	130.4	130.8	165.1	0.0	1.7	5.2
Ngare Nyting	1	9.2	14.1	19.3	0.0	0.0	0.0
Ngare Ndare	1	10.4	13.8	0.0	0.0	10.4	13.8

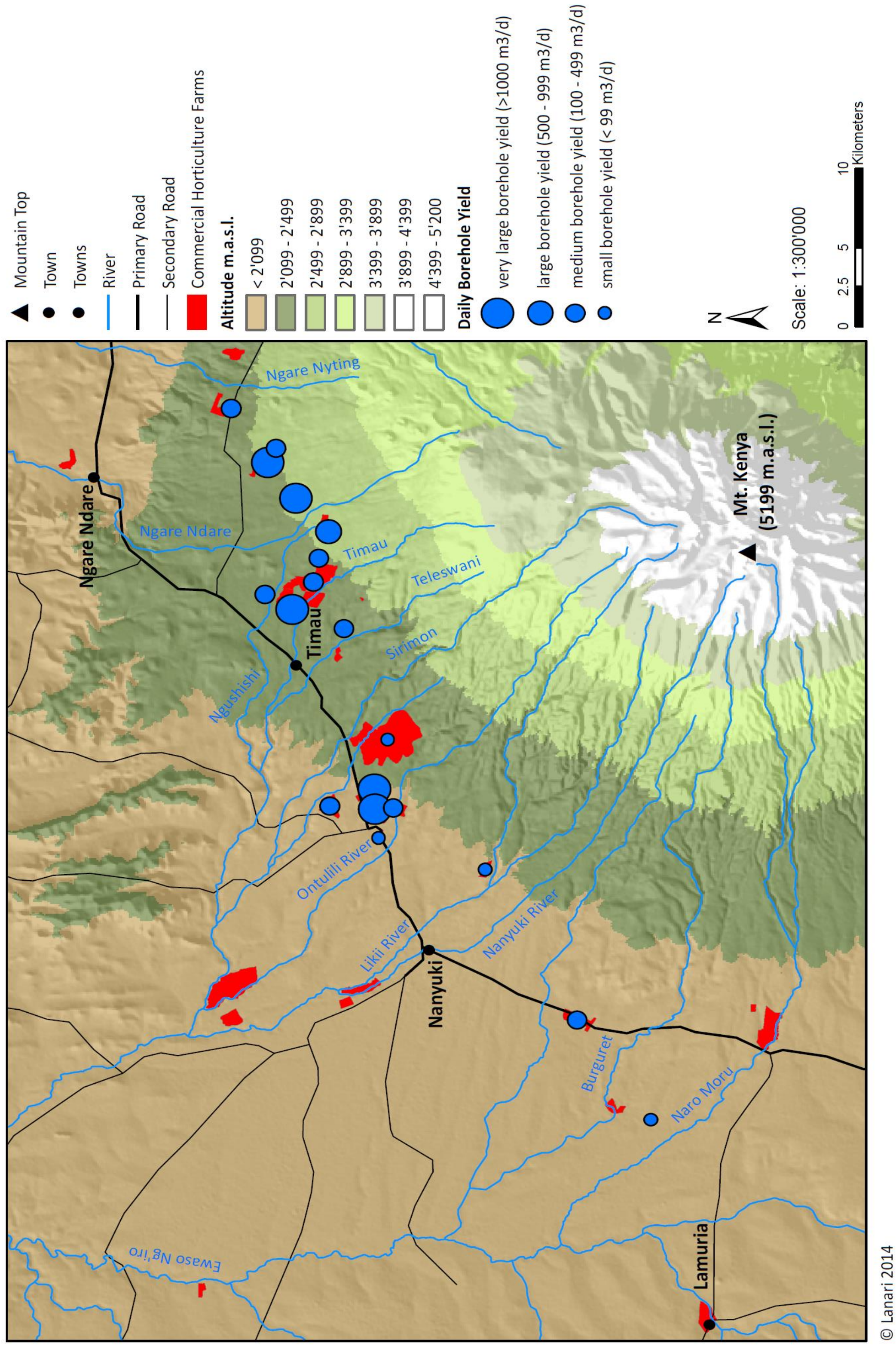
Total [l/s]	Total [/s]	Total [m3/s]	Total [m3/s]	Total [l/s]	Total [l/s]
750	**1955**	**782.9000**	**31.8000**	**36**	**146**
Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]	Total [m3/d]
64791	**168929**	**67643**	**2748**	**3071**	**12652**

Mean dry season water quantity abstracted per river (Wemp) [l/s]	Mean dry season water quantity abstracted from river (Wdem) [l/s]
3.55	**14.64**

Appendix VII: Transformation of Area under Horticulture and Water Sources of the Farms Persisting Since the First Study

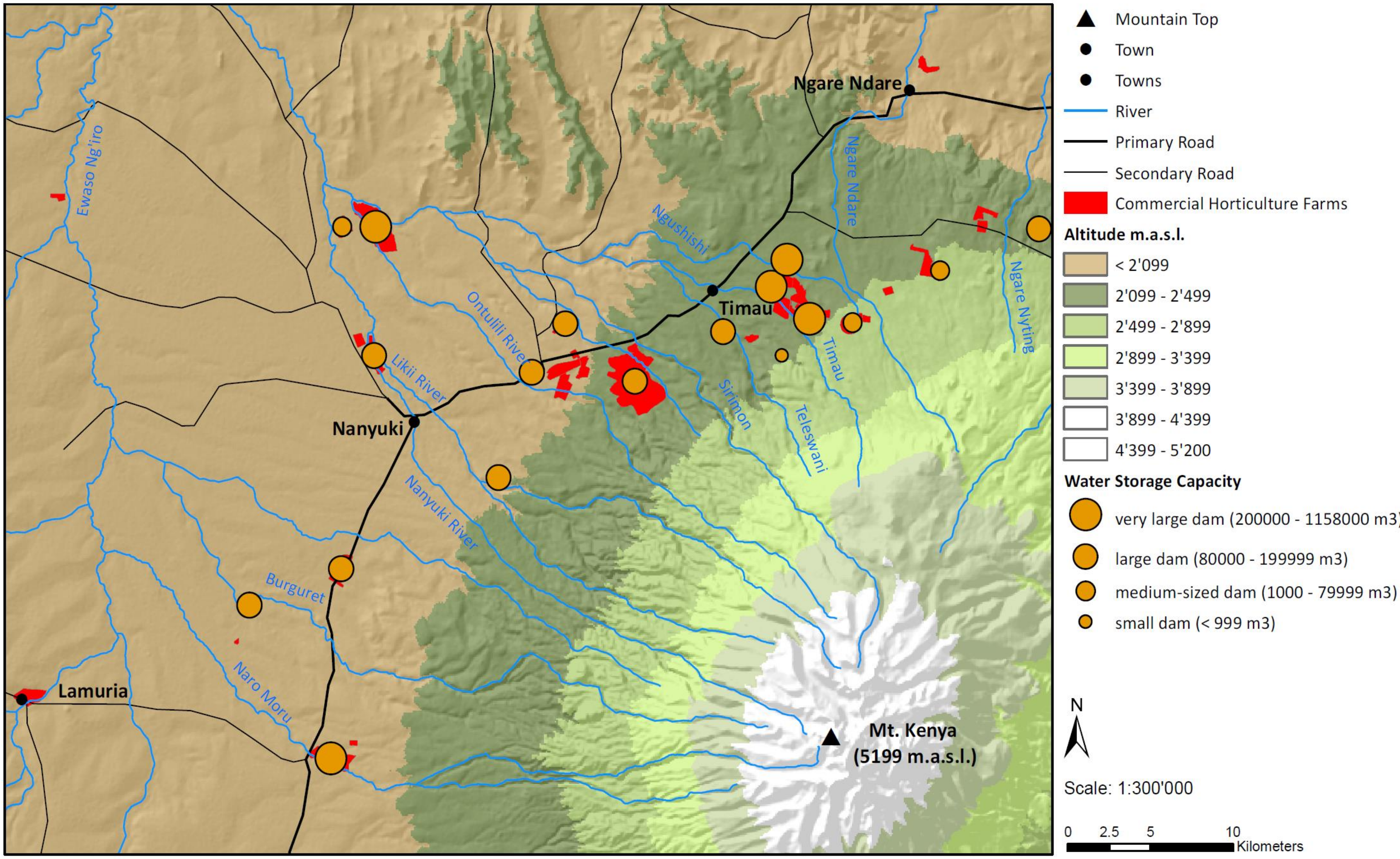
Code of Enterprise 2013	Area under horticulture in 2013	Storage Capacity for Dry Season Irrigation in 2013	Amount of daily water use in dry season contributed by borehole pumping in 2013	Amount of daily water use in dry season contributed by borehole pumping in 2003	Storage Capacity for Dry Season Irrigation in 2003	Area under horticulture in 2003	Code of Company 2003
	ha	[m3]	[m3]	[m3]	[m3]	ha	
E1	121.4	60,000	949.3	216	12,000	57.5	C4
E2	12.1	no storage	no borehole	no borehole	no storage	25	C20
E3	15	no storage	450	no borehole	small dam, no data	30	C12
E4	20.1	150,000	no borehole	no borehole	no storage	14	C11
E5.1	10	no storage	256.44	69.12	no data	7	C8
E5.2	9	yes, but no precision	230.796	No Farm in 2003			
E6	10.1	30,000	no borehole				
E7	15	150,000	no borehole	no borehole	100,000	12	C3
E8	15	53,000	282	No Farm in 2003			
E9	8	400	no borehole				
E10	15	no storage	225				
E11	20	232,000	400	3154	53,000	190	C16
E12	23.5	121,000	12.144	No Farm in 2003			
E13	22	no storage	1300				
E14	32	162,000	15	no borehole	80,000	25	C1
E15.1	250	930,000	no borehole	borehole, but no data	124,000	68	C17.1
E15.2	31	126,000	no borehole	borehole, but no data	120,000	44	C17.2
E16	18.5	150,000	no borehole	no borehole	storage, but no data	5	C7
E17	86	320,000	1280	No Farm in 2003			
E18	7	in construction	210				
E19.1	57	no storage	5130				
E19.2	22	no data	no data				
E20	24.2	no storage	1936				
E21	25	no data	no data	no borehole	16,200	36	C23
E22.1	23	180,000	no borehole	no borehole	50,000	39	C18
E22.2	21	160,000	338.1	No Farm in 2003			
E23	4.5	no storage	51.3				
E24	162	1,158,000	no borehole				
E25	20	no storage	no borehole	no borehole	no storage	48.2	C22
E26	4	no storage	no borehole	no borehole	storage but no data	5	C2
E27.1	56	90,000	250	No Farm in 2003			
E27.2	86	250,000	no borehole	no borehole	200,000	39	C21
E28	56.6	no storage	2547	397.44	no storage	10	C13
E29	no interview data	no interview data	no interview data	no borehole	no storage	45	C24
E30	no interview data	no interview data	no interview data	no interview data	no interview data	no interview data	C26

Appendix VIII: Additional Maps



Daily Borehole Yield of Commercial Horticulture Farms Northwest of Mt. Kenya

Water Storage Capacity of Commercial Horticulture Farms Northwest of Mt. Kenya



Appendix IX: Interview Guide for Interviews with Persons In Charge of Medium- and Large-Scale Horticulture Companies

Statistical indications	Code of interview: _E________________ Date of interview: ________________________ Starting time/ending time: _________________

May I tape this conversation?

Name of company: ____
Name of farm: ____
Name of interviewee: ____
Position within management: ____
Since when working in that position: ___________________________________
Since when working for the company? ___________________________________

Section 1: Development

1.1 Past development

1.1.1 Establishing phase

1. Could you please describe how your horticulture business was started in this particular region?
2. When was it initiated?
3. Did you already have a **ready market** or even a contract to sell your produce **before** you started production in the region? Or what was the development of this?
4. **Was your company already dealing with horticulture anywhere before taking up production in the region NW of Mt. Kenya? Where? When** was it started on these other sites?
5. What were the **reasons** to go into **horticulture**?
6. Why horticulture **in this particular region**? What are the regions **advantages** in terms of (medium- or large scale) horticulture?
7. What were the **obstacles** to overcome **while establishing** your company in the region?

1.1.2 Development from initiation up till now

8. **Could you please describe the development of your horticulture business since initiation/2002** (if company already existed during first study) **up till now?**

9. What were the **reasons for these developments/changes in your opinion**?

10. What were the **changes within your company** which affected the development in any way?

11. What were the **changes outside** your company which had influence on your horticulture business?

12. Which of these would you refer to **as most crucial for the development** of your company?

13. What were **major constraints** on your business since initiation of production up till now?

1.1.3 Development of large-scale horticulture in the region NW of Mt Kenya

14. **The large-scale horticultural sector NW of Mt. Kenya seems to have been growing at a high rate. In your own opinion, what are the circumstances which have facilitated this development?**

15. Were there any **political circumstances** or **policies** either on the **national level or a regional** one which either **supported** or **impeded** the build up of your business here? Please name them!

16. How would you describe the development of the large-scale horticultural sector NW of Mt. Kenya **compared to the Kenyan horticultural sector as a whole in the same time**? What are the **differences?**

17. And compared to **other region within Kenya** where horticulture is concentrated? Have there been any differences?

18. What are the **reasons for** the **differences**?

1.1.4 Development of the land tenure and land use

19. **Does your company own the land?**

- **If yes, who owned it before?**

- If no, who owns it? What contract does your company have with the owner?
    - Leased for how long? / ....

20. **What** was **produced** on the farm(s) **before** you established horticultural use?

21. When was the land purchased/leased?

22. Was the size of this farm the same before your company purchased/leased it as it is today?

1.2 Future perspectives

23. **What are your plans for the future of your business** (Expansion? Concentration? Any investments in infrastructure? Others?)**?** Within **what time**?

24. **What current circumstances have major influence, either positive or negative, on the future of your company?**

25. **What are major obstacles to the development of the company (the section of it situated in this region here)?**

26. What **future trends within the horticulture sector** as a whole do you expect?

27. What makes you think that these are the future trends? What are the signals leading in this direction?

28. **How** do you think will these trends **affect** your business in this region here?

29. **Where do you see** your company in **5-10 years?**

Section 2: Current situation

2.1 Production

2.1.1 Crops

1. **Which crops are grown?**

Name of crop	**Area of cultivation (ha)**	**Mean annual tonnage of production, raw material (t)**	**% marketed of the total per crop**

2. **Have there been changes in the number of different crops cultivated since initiation/2002? If yes: Were you concentrating production or were you diversifying it? Due to what reasons?**

3. **What was the total raw material production in tons in the year 2012?**

4. **How has the total raw material production in tons per year developed since initiation/2002** (if company already existed during first study)**? What was the rate of change (growth/decline) per year?**

5. **What were the reasons for this development?**

6. **What was the yearly return 2012 achieved on your farm(s) in this region (in Ksh)?**

7. **How did the rate of the return per year change since initiation/2002** (if company already existed during first study) **of production in this region?**

8. **Were there years of major steps in this number or was the development of it taking place in a regular way?**

2.1.2 Area

Name of the farm	Farm area (ha)	Total area under cultivation per season (ha)	Area under Horticulture (ha)	Year of initiation	Cultivated crops

9. **What is the total area under cultivation during dry season?**
10. **What is the total area under cultivation during rainy season?**
11. **Due to what reasons are these seasonal differences?**
12. **When do you plant?**
13. **When do you harvest?**

2.1.3 Prices

14. **Within what range do prices for your products fluctuate on your main market/buyer?**

Location of market/buyer	Name of crop	Range of price fluctuations Ksh

Name of crop	Exported tonnage	Exported % of total production per year

15. **What has the development of the prizes been since initiation of production?**

16. **What were the reasons for this development?**

2.2 Market orientation

2.2.1 Export

17. **What is the percentage exported of your total production per year?**

18. **Which crops are exported?**

19. **Have there been changes in this since initiation/2002** (if company already existed during first study) **of your horticultural production in the region? If yes: What were these changes? Due to what reasons?**

20. **What are the importing countries?**

Country	Tonnage imported per year	In % of your total production

21. **Which companies in the importing countries act as vendors of your products?**

Name of company	Description	Country

22. **What were the major changes in your export pattern since starting up/2002** (if company already existed during first study) **horticulture in the region?**

2.2.2 Other markets (local, regional, national)

23. **Which other markets are served by your production?**

Name of market	Located at:	% of total production	Sort of crops

2.3 Network of product distribution (commodity chain)

2.3.1 Export

24. **Could you please describe the chain of the distribution of your products from your farm(s) to the consumer and the different agents involved in this?**

Description of Agent	**Located at:**	**Main Task**	**Estimated importance in relation to the other agents**

25. **Have there been changes in this chain since initiation/2002** (if company already existed during first study)**?**

2.3.2 Domestic marktet

26. **Which agents are involved in the distribution of your produce within Kenya (between your farm and the consumer)?**

Description of Agent	**Located at:**	**Main Task**	**Estimated importance in relation to the other agents**

2.3.3 Horticultural organisations & Labels

27. **Which horticultural organisations is your company a member of?**

Organisation	**Located at:**	**Tasks**	**Since when member?**

28. **What are the benefits these bodies provide to your company?**

29. **What are the requirements these bodies call for from their members?**

30. **How do these organisations ensure that the requirements are met?**

31. **What label does your company carry?**

Label	Located at:	Aspect labeled	Since when member?

32. **What are the benefits these bodies provide to your company?**

33. **What are the requirements these bodies call for from their members?**

34. **How do these organisations ensure that the requirements are met?**

35. **How does this label change/affect your production & distribution process?**

- value of production / cost of production

36. **What were major changes in the organisation of the distribution of your goods (commodity chain) in the past?**

2.3.4 Processing

37. **Are products processed before they are leaving your company?**

If yes: What kind of processing is carried out?

Where are the processing facilities located?

Have you been processing the goods since production was initiated in the region?

2.4 Resource use

2.4.1 Water sources

38. **What is your main water source?**

39. **What is the percentage of the total used water contributed by this main water source?**

40. **What is the total amount of water contributed by this source (in l/d or m^3/d)?**

41. **What other water sources do you have?**

Water source	Contribution to the total amount of water used (%)

42. **In this distribution, are there any seasonal changes? If yes:** What are the **reasons** for these adjustments?

43. **Since initiation/2002** (if company already existed during first study) **of horticultural production, have there been changes in the importance of the various water sources to your farms?**

44. **What is the amount of water permitted to abstract from the river?**

45. **Is your water metered?**

2.4.2 Water use / Irrigation

46. **How is the water delivered to your farm?**

47. **Of the total available water on your farm, what percentage is used for irrigation?**

48. **Have there been any changes in the past in the share of the total available water used for irrigation? In what way?**

49. **What is the rest used for?**

Water use	**% of total water use**

50. **Do you adjust the water use for irrigation to seasonal changes in water supply? Could you please describe how your water use is adjusted?**

2.4.3 Irrigated area

51. **What is the total irrigated area per farm?**

Name of the farm	**Irrigated area (ha)**

52. **Are there any changes in the irrigated area during the year? If yes: How does the irrigated area change during the year? What are the reasons for the changes?**

Name of the farm:	
Seasons	**Irrigated area (in ha)**
Dry seasons	
Rain seasons	

Name of the farm:	
Seasons	**Irrigated area (in ha)**
Dry seasons	
Rain seasons	

53. **Have there been changes in the past in terms of the total irrigated area? If yes: What has the development of the total irrigated area been like up till now? What were the reasons for this development?**

2.4.4 Irrigation technologies

54. **What different irrigation technologies are currently applied on all of your farms?**

Applied irrigation technology	**Percentage of the total area irrigated by respective technology (%)**

55. **Based on what criterions do you apply the different irrigation technologies?**

Criterion	**Applied technology**

Sort of crop:	
Stage of growth:	

Others please specify!

56. Have there been changes in the past regarding applied irrigation technologies?

If yes: What were these changes?

When were they carried out?

What was the motivation to do so?

57. Do you plan to execute any changes in your irrigation activity in the future?

If yes: What changes?

For what reasons?

58. What is the efficiency of your irrigation activities in l/ton produce ("how many drops per crops?")?

2.4.5 Water quality

59. Do you use chemicals such as pesticides, fungicides, fertilizers or others?

If yes: What chemicals are used?

Sort of chemical	**Amount of kg used per year**

60. Based on what criterions are chemicals applied?

61. Which organisations put up guidelines for the use of these chemicals?

62. How do they ensure that these standards are met?

63. Do you have any kind of water recycling facility on your farms? If yes: By what method is waste water treated?

2.4.5 Water conflict awareness

64. In your own view, has there been conflict potential between the various water users during the past years (since initiation/2002)**? If yes: In what way were you confronted by this conflict potential?**

65. What is your opinion on that situation?

66. What is your strategy to counteract water conflict potential?

67. Do you assist the adjacent communities to reduce the water conflict potential?

If yes: In what way?

Since when

68. **Is your company a member of a River Water User Association?**

If yes: Which RWUA are you a member of?

Since when are you part of this association?

What was your motivation to join?

What is your contribution to the functioning of the RWUA?

2.5 Socioeconomic significance

2.5.1 Labour

69. **How many people work on your farm/all your farms in the study area NW of Mt Kenya?**

70. **Of this number, what are the percentages of permanent and casual workers at the moment?**

Permanent employees: **Whereof women:**	**Casual workers:** **Whereof women:**

71. **How did these numbers develop in the past?**

Year since initiation of production in the region	**Number of permanently employed persons**	**Number of casual workers**
Initial stage	Whereof women:	Whereof women:
2 years	Whereof women:	Whereof women:
4 years	Whereof women:	Whereof women:
6 years	Whereof women:	Whereof women:
8 years	Whereof women:	Whereof women:
10 years	Whereof women:	Whereof women:

72. **Are there any fluctuations in terms of number of workers at your company due to seasons?**

If yes: When is the peak of the number of people working on your farm(s) and at what height is it?

When is the lowest number of employment reached during the year? What is this number?

73. **Have there been any problems to acquire enough labour?**

If yes: Due to what reasons

74. **What development for the number and distribution between the two categories (permanent employed, casual) do foresee for the near future** (next five years)?

75. **What is the estimated rate of change in numbers of employees for the near future** (next five years)?

76. **How many people work on each of your farms** (if more than one farm)**?**

Name of the farm	Number of workers Permanently employed / casual / seasonal
	/ /
	/ /
	/ /
	/ /
	/ /

77. **What is the number (or percentage) of non-skilled workers at your company?**

Name of farm	Number of non-skilled workers

78. **Where do the non-skilled workers mainly live?**

79. **As far as you know: Have they moved from anywhere to this region due to job opportunities? Where from?**

80. **Where do the skilled workers mainly originate?**

81. **Does your company have any employment policy regarding local workers?**

    If yes: What is its aim and how is it applied?

82. **How do you acquire your labour? Please describe!**

83. **What are the average working hours of a worker at your company per week?**

84. **What are the workers' wages per day on your farm(s)?**

Permanently employed:	
Seasonal workers:	
Casual workers:	

85. **What is the monthly paybill your company pays in terms of labour costs?**

2.5.2 Labour welfare

86. **Besides the regular income, do you provide other services to your employees?**

    If yes: What kind of services?

Services to the employees	
Social security insurance	
Health care	
Education	
Transport	
Pension	
Social activities (such as sports clubs etc.)	
Others, please specify:	

When did you start to provide these services to your employees?

Do the **surrounding communities** (people not working at your company) also **profit** in any way by the provision of these services? If yes: in what way?

2.5.3 Community support

87. **Does your business have any influence on community infrastructure?** If yes: In what way?

88. **Does your company invest directly into community infrastructure?**

    If yes: What is the trend of the investments in the public infrastructure over the past years?

89. **What projects or issues does your company support?**

Categories of projects	**Investments per year (KES)**
Roads	
Electricity supply	
Schools	
Markets/stores	
Hospitals	
Water supply for community	
Others, please specify:	

90. **Where are they located?**

91. **Due to what reasons do you invest in these projects?**

92. **Do you plan to expand such investments for the near future?** If yes: Into **what projects** do plan to invest?

93. **Apart from direct support, are there any other influences on the surrounding communities triggered by your business activity?** If yes: Which ones and in what way?

2.5.4 Local economic relations

94. **What kind of economic interactions between your company and the surrounding communities do exist?**

95. **What services does your company purchase on the local markets?**

96. **What commodities does your company purchase on the local markets?**

2.5.5 Outgrowers

97. **Do you contract any outgrowers? If not: Do you consider contract farming for the near future?**

98. **Who are your outgrowers and where are they located?**

Name of Farm and farmer	Farm located at:	Type(s) of crops delivered:	Average tonnage per year delivered:

99. **Since when do you contract outgrowers?**

100. **Could you please describe how the co-operation between your company and these outgrowers is organised?** (Transport?, Fixed amount of a certain crop or fluctuating? Who carries the risk of loss of production due to unforeseen occurrences such as droughts? Short-term or long-term co-operation/orders? Fixed prizes?)

101. **What is the annual contribution of all the outgrowers to the total output of your company per year (in %)?**

102. **Do you have any kind of monitoring of their production?**

103. **Do you provide any sort of support to your outgrowers?** (technically, in terms of infrastructure, socially, others…?)

104. **What is the benefit to your company in having contracted farming?**

Final question:

105. **What is the closest large-scale horticultural farm to yours?**

106. May I get back to you in case I have follow-up questions?

Comments from the interviewee?

Erklärung

gemäss Art. 28 Abs. 2 RSL 05

Name/Vorname:	Lanari Nora
Matrikelnummer:	08-305-393
Studiengang:	Master of Science in Geography
	Bachelor ☐ Master ☐ Dissertation ☐
Titel der Arbeit:	Development of the Commercial Horticulture Sector Northwest of Mount Kenya from 2003-2013 and Its Impact on River Water Resources of the Upper Ewaso Ng'iro Basin
LeiterIn der Arbeit:	Prof. Dr. Urs Wiesmann

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Unterschrift