1 Introduction

1.1 Problem statement

Only 16% of the area in the Middle-East is arable land (Dowling, 2009). The rest consists of marginal land and desert, used by Bedouins to raise livestock. Small ruminants are playing a major role in the Bedouin livestock production, representing one of their most important income sources. As pastoralists, Bedouins followed available resources of pasture with irregular movements, but country borders and settlement activities changed this lifestyle drastically in most areas of the Middle East. The compulsory schooling of children and governmental sedentarization programs have changed Bedouin lifestyle from nomadic to a more transhumant, or even settled one. Additionally, a decrease in resources of land and water, together with changing market conditions forced Bedouin sheep farmers to continuously adjust their production system and their respective inputs to market conditions. Abu-Rabia (1984) has found that several Bedouin sheep farms in the Negev face continuous economic losses. Especially in marginal areas it is thus very essential to choose the right type and quantity of input (Nudell et al., 1998) for an efficient production. In the Negev desert in Israel, tradition-oriented, extensive systems co-exist besides more intensified systems with a high market-orientation (Rummel et al., 2003). The production systems in place follow different livelihood strategies and generate a large variety of outputs with varying economic success (Ginguld et al., 1997). But what type of input influences the economic success of sheep farming in the Negev and what type of production system is most efficient? The definition of different production systems is by itself complex and requires a common input or output parameter, taking account of the diverse livelihood patterns. Rummel et al. (2003) used the output of marketable lamb meat equivalent (kg/ewe/year) for a classification. As lamb meat is the main output of sheep production in the Negev, a comparison of Bedouin sheep farms according to their biological output seems appropriate for this study.

One influence on the biological output is new breeding technologies. Many authors analyzed Bedouin livestock production in the Negev according to inputs like access to pasture, herd size, capital or labour (Abu-Rabia, 1994; Degen et al., 2000, Stavi et al., 2006). The role of new breeds or new reproductive technologies has not been investigated so far.

During the last decade more and more Bedouin farmers in the Negev introduced breeds with a high prolificacy into their flocks, even without the knowledge of their suitability. Further, they intensified their breeding by use of hormonal synchronization and artificial insemination (SVC, 2007). The efficiency of applying these new reproductive technologies under the harsh environment is not known yet. The question arises therefore, in which system and under which conditions the introduction of new breeds and breeding technologies is profitable and whether it contributes to an efficient sheep production in the region. Chambers et al. (1998) stressed further the difficulty to transfer modern technology to traditional agriculture due to

problems in adoption behavior of farmers. While genetic improvement programs increase animal productivity, they also depend on high inputs. According to Gabiña and Seradilla (2000) many problems might occur by the use of high prolific breeds, if farmers are unable to adjust their management practices accordingly. On the other hand, sheep production has to be profitable and efficient or it might not be sustainable (Bett et al., 2009b).

To investigate the suitability of improved Awassi lines, improved breeds were introduced to Bedouin sheep flocks in the region in the frame of a multilateral DFG project with the aim "to improve meat and milk production of fat-tailed sheep of the Middle East through breeding". The present study is part of this project and was concerned with the introduction of the highly prolific Afec Awassi breed into selected Bedouin flocks of the Negev area. The aim of the study is to assess the aggregated performance under different production conditions by an on-farm performance testing.

However, in the assessment of the best suitable genotype for a local farmer, the views of the scientist and of the local farmer may differ widely, especially in tradition- and subsistence-oriented agriculture (Bosman et al., 1997). A "good ewe" might not be the one with the highest performance under good conditions, but an animal with a reasonable performance under marginal production conditions. Genetic improvement of local breeds has therefore to be linked to specific breeding objectives in the respective production environment (Kosgey and Okeyo, 2007). Thus, in addition to the performance analysis, the breeding goals of Bedouin farmers throughout the Negev have to be identified and considered in an evaluation of the breeds for future breeding activities.

1.2 Objectives of the study

The main objective of this work is to assess the performance of local or improved breeds and crossbreds kept under diverse Bedouin sheep production conditions and the role of new breeding technologies in achievement of an intensification process. Thus, the present study intends

a) to identify and describe different Bedouin production systems;

b) to assess the impact of new genotypes and new reproductive technologies on the efficiency and the sustainability of farms;

c) to assess the performance of different Awassi lines under their respective production conditions and

d) to identify trait preferences of Bedouin sheep farmers to be considered in future breeding.

1.3 Structure of the thesis

Chapter 2 gives a general introduction into sheep farming and the function of sheep for Bedouins with focus on the Negev, as an example for a rapidly changing production environment. Material and methods are given in Chapter 3 and Chapter 4 presents and discusses the results. Existing Bedouin sheep production systems and the flock production level in the Negev are described and factors with impact on their biological and economic performance are identified. The biological output served hereby for a classification of farms. Socio-economic factors and the breed composition of the flock are on focus, considered as relevant factors in an intensification process. Farms are further evaluated according to their economic success. Changes in sheep production found after a two-year period of observation are displayed. The impact of breeding and reproductive technologies on the economic success of the farms is hereby illustrated. Critical control points in semi-intensive Bedouin sheep production are also identified and discussed. In a further section the aggregated performance of different Awassi lines in their respective production context is given. The suitability of the different genotypes is evaluated according to the output of kg weaned lamb meat per lambing ewe. The last section of this chapter describes the criteria of Bedouin sheep farmers, used in their selection of ewe and ram replacement. Results of a ranking of the most important traits are presented and compared with results from other pastoral systems. Finally, all results are generally discussed in Chapter 5 and summarized in Chapter 6.

2 Literature review

2.1 Sheep production in the Near East

In Near Eastern countries animal products are one pillar of the food security and animal production has been practiced for centuries in the region due to the high percentage of non-arable land (Razavi and Khavanin-Zadeh, 2005). Animal products are also important in most of these countries due to cultural, traditional and religious reasons. The demand for red meat in the area increased remarkably during the last decades, driven by a rapid population growth and an increasing purchasing power (Bahady et al., 1998, Shomo et al., 2010). A change in consumption preferences in favor of sheep meat was reported by Gürsoy (2006). The importance of meat from small ruminants increased also in comparison to meat of large ruminants, as small ruminants are able to survive in areas where cattle have difficulties performing or where resources are limited (Zygoyiannis, 2006). IFAD (2000) observed a shift from large ruminant based systems, to small ruminant production systems in the Near East and North African (NENA) region. It is thus not surprising that IFAD (2000) reported raising numbers of sheep over a period of more than 60 years, illustrated in Table 1. The Table shows further a stronger increase in small ruminants than in cattle during the period of 1961 to 1997.

Table 1: Growth rate of livestock in the NENA region (numbers in Millions)

Item	1961	1983	1997	Increase between 1961-1997 (%)	Increase between 1983-1997 (%)
Sheep	156.07	237.89	256.67	64	8
Cattle	57.2	75.93	80.76	41	6
Goats	90.78	126.72	144.46	59	14
Livestock Units	73.73	97.21	104.72	42	8

Source: modified from IFAD 2000

Also after the year 2000 the number of sheep increased in the Near East. Table 2 shows the development in sheep stock (in 1000 heads) and the sheep meat production (in t) in selected Middle East countries (SMEC) according to FAO STAT (2011) over a period of 5 recent years. Except for Lebanon, where the number of stock declined, all NME countries increased there sheep stock. The total sheep stock in those selected countries represents 2-3% of the sheep stock of the world. The overall increase in stock rate in the NME countries exceeded the world rate.

Over this 5 years period, there are large differences between the countries in change of stock demonstrated in Table 3.

Table 2: Development of sheep stock (in 1000 heads) and indigenous sheep meat production (in t) in selected Middle East countries (SMEC) and in the world

	Sheep stock (1000 heads)			Sheep meat production (t)		
Country / Year	**2004**	**2006**	**2008**	**2004**	**2006**	**2008**
Egypt	5,043	5,385	5,498	40,426	44,141	44,179
Israel	420	445	430	5,600	6,000	6,000
Jordan	1,529	1,972	2,493	15,444	12,610	15,445
Lebanon	305	370	330	11,506	7,304	8,140
Syrian Arab Repub.	17,565	21,380	22,865	161,308	187,467	184,500
Total SMEC	24,862	29,552	31,616	234,284	257,522	258,264
World	1,067,798	1,106,592	1,096,327	7,820,470	8,276,007	8,528,218
SMEC/ World	0.02	0.03	0.03	0.03	0.03	0.03

Table 3: Change in sheep stock and in sheep meat production (in %) in selected Middle East countries (SMEC) over a 5 years period

	Change from 2004 to 2008 in	
Country	**Sheep stock**	**Sheep meat production**
Egypt	+ 9.0%	+ 9.3%
Israel	+ 2.4%	+ 7.1%
Jordan	+ 63.1%	± 0.0%
Lebanon	+ 8.2%	- 29.3%
Syrian Arab Republic	+ 30.2%	+ 14.4%
Total SMEC	+ 27.2%	+ 10.2%
World	+ 2.7%	+ 9.1%

Source: own calculation according to FAO STAT (2011)

Within the years 2004 – 2008, only Israel managed to increase its sheep meat production with a rate that is higher than the increase in sheep stock (Table 3). While meat production showed a stagnating rate in case of Jordan, it even decreased in Lebanon. The productivity of the animals seems thus to be better in Israel than in the neighboring countries. Rummel et al. (2003) found also the highest production rate in terms of mutton and lamb production per ha agricultural area in Israel (9.2 tons/ha), compared to the whole Near East region (2.8 tons/ha) (data based on FAO agrostat 2001).

The production systems in place and the breeds used are playing a central role. Aw-Hassan et al. (2005) describe the productivity of the animals, raised mostly under extensive to semi-extensive conditions as rather low. Hamadeh et al. (1996) and Wachholtz (1996) found also differences in the production levels of sheep farming systems in Lebanon and Syria respectively, with large ranges. According to the FAO (1995), there is a difference of 19 kg produced live weight per ewe and year between extensive, pastoral systems and semi-intensive production systems in Near Eastern countries. Israel Rummel et al. (2003) identified

an estimated difference of 82 kg in marketable lamb meat per ewe exposed and year between an intensive system with improved genotypes and an extensive system based on the unimproved local breed. This wide gap illustrates the possibilities in sheep production in terms of productivity, but also in terms of profitability.

Both aspects are becoming more important in the region since droughts force stakeholders in most Near Eastern countries to purchase additional feed. In Sudan and Yemen, for example, the purchased feedstuff comprises already 50% and 70%, respectively, of the total feed (IFAD, 1998). High feed prices are thus a challenge for the sustainability of the sheep production in the Near East. In Jordan the government provides subsidized feed to Bedouin farmers to help them in sustaining their flocks (Rowe, 1999). Overgrazing as a result of high stocking rates in marginal and desert areas has further been reported in many countries, calling for more efficient sheep production. In the opinion of Degen et al. (2001) improvements in all aspects of livestock rearing (health, management, husbandry and breeding) are thus needed to keep sheep production in the area efficient and sustainable. As the majority of sheep in the Near East are kept by Bedouins, their sheep production systems are on focus in the following section.

2.2 Sheep production in Bedouin communities

The word “Bedouin” or “badawi” describes an Arab of any of the nomadic tribes of the Arabian, Syrian, Nubian, or Saharan deserts (AHD, 2009), depending on livestock for their livelihood (Degen and El-Meccawi, 2009). Sheep were one of the most important means of livelihood for the Bedouins, being well adapted to fluctuating feed availability (Iñiguez, 2005). Since trading, one of the former main income sources was reduced or even made impossible by national borders and since settlement activities were subject to the political agendas of Near Eastern (NE) countries, the Bedouin way of life altered drastically. In Syria, agricultural policy reforms changed Bedouin farming systems, with rangeland being cultivated, Bedouins settled and their livestock production system transformed (Ngaido et al., 2001). The authors describe the change in livelihood in the 1960’s from Bedouin nomads to agro-pastoralists with short transhumant periods and Masri (1991) observed a shift from camel to sheep. The tribal grazing networks were herewith largely destroyed. Later, in the 1990’s, the government stopped the extension of rangeland cultivation due to increasing degradation and Bedouins were forced back to a more transhumant or nomadic production system, having lost original grazing rights. The Syrian Badia (desert and steppe area) supplies only 20-25% of the annual feedstuff today because of the progressive degradation, explaining the existence of semi-extensive production besides the extensive one. While nomadic Bedouins practice extended migration to marginal and remote areas, settled Bedouins follow a semi-extensive system combining grazing near the settlement with additional feeding (Iñiguez, 2005). Shepherding by family members or by hired labour is common in both systems.

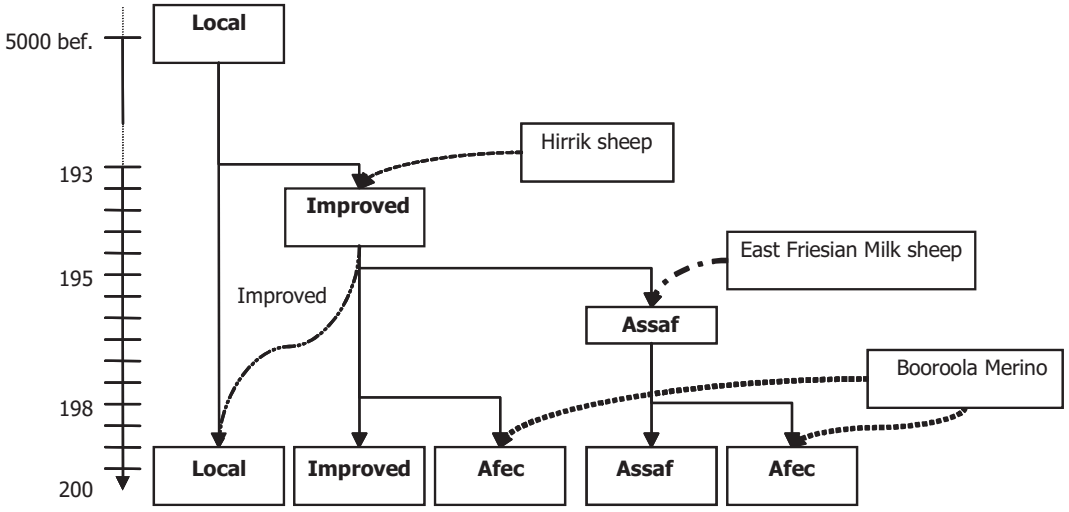
Also in the Badia of Jordan pastoralism and Bedouin lifestyle changed due to state intervention. The subsidy of supplementary feedstuff introduced in the 1970's led to the reliance on governmental benefits. The growth of national markets and improved infrastructure resumed further in a commercialization of the sheep production (Rowe, 1999). According to the author, all desert land, including the Badia area, came under state ownership after the legislation in 1971 and was suddenly open to "universal access". Thus, the former traditional grazing rights were put out of place in a similar way as in Syria. The provision of state services, e.g. water and schooling, encouraged the sedentarization process of Bedouins in the Badia. Thus, the majority of Bedouins possess stone houses nowadays, even if practicing transhumant pastoralism. According to Campbell and Rowe (1998) management practices were altered as well by a stronger market orientation, leading to a specialization in production lines (lamb meat or milk), an increase of sheep in relation to goats and an intensification of herding with the use of hired shepherds.

A similar development in Bedouin sheep production was described by Ginguld et al. (1997) for the Negev Bedouins in Israel. Herding practices in the period of the World Wars ranged from semi-nomadism to agro-pastoralism, accompanied by a beginning sedentarization (Meir, 1988). During the independence war in the region many Bedouins fled to neighboring areas, today Jordan, Egypt and the Palestinian Territories. Nomadism was stopped abruptly after the foundation of the State of Israel in 1948 and the designation of borders. The remaining Bedouins in the Negev were moved to the so called "Siag", an assigned area around Beer Sheva, where movements have been controlled (Marx, 1974). The land was annexed by the government of Israel restricting its use. After the 1960's Bedouins were allowed again to move with their animals to spring grazing sites nearby. The grazing pattern up to the present day is regulated by the Ministry of Agriculture in time, movement, space and respective flock size (MA, 2007). Sheep production of Bedouins in the Negev and elsewhere was thus adapted to government regulations and to ecological and geographical constraints (Ginguld, 1997). Due to these constraints, well adapted local breeds are the main sheep breed in Bedouin flocks.

2.3 Local sheep breeds in Israel

Wilson (1991) grouped sheep according to their tails into thin-tailed, fat-tailed or fat-rumped. In Israel, thin- and fat-tailed sheep breeds can be found. While the thin-tailed breeds are predominant in private sheep farms, the predominant breed in Bedouin flocks has been for centuries the local, fat-tailed Awassi (AW), due to its good adaptation to harsh desert conditions. It comprises about 50% of the sheep population in Israel. The local Awassi is known to be tolerant to heat, water stress, nutritional fluctuations (Epstein, 1982) and resistant to some diseases and parasites (Mason, 1967; Gürsoy et al., 1992, 1993). The fat-tail is especially important as an energy and water conserving organ (Darling and Farvar, 1972). But the low milk yield, growth rate and prolificacy of about 1.0 lamb per lambing ewe (Epstein,

1985) gave reason for genetic improvement programs, started by Jewish settlers. Continuous genetic improvements by selection and later by crossbreeding and major gene introgression lead to different Awassi lines in Israel. The breeding history of these different lines is illustrated in Figure 1.



Source: Rummel et al., 2005

Figure 1: Breeding history of different Awassi genotypes in Israel

Besides the local Awassi, settlers bought Hirrik sheep from Turkey (Epstein, 1985) and started to select on milk yield. The Improved Awassi with a high milk yield and 1.2 lambs per ewe and per lambing (LB/EL) resulted from this stringent selection (Galal et al., 2006). The Improved Awassi was followed by the Assaf, a composite breed of Improved Awassi and East Frisian, with an original gene proportion of 3/8 East Frisian and 5/8 Improved Awassi. Assaf (AS) shows a higher prolificacy of 1.6 LB/EL, but the breed was found to be less adapted to harsh conditions (Gootwine and Goot, 1996). Examples of the local Awassi sheep and of the Assaf sheep in Israel are shown in Figure 2 and 3.

Further genetic improvement was done in Israel by the introgression of the Fecundity Booroola (*FecB)* gene into the Improved Awassi by a crossbreeding program with the Booroola Merino shown in Figure 4. Merino is an exotic meat breed, which was imported to Israel from Germany (Gootwine et al., 2008). FecB is a dominant gene having a strong effect on the ovulation rate in sheep.

Figure 2: Local Awassi flock

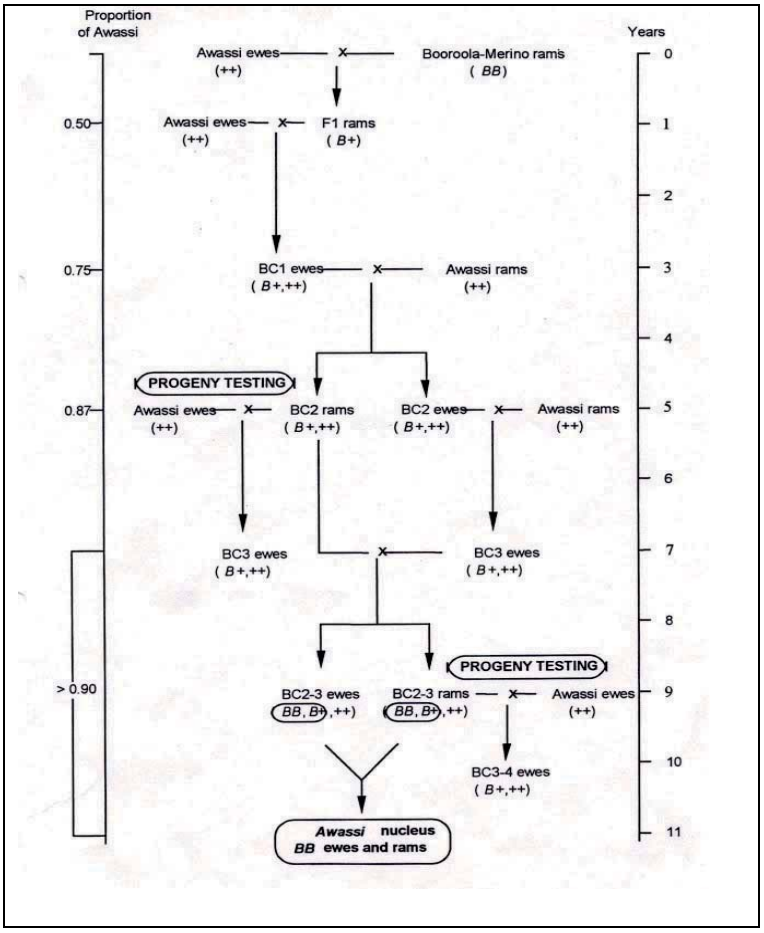
Figure 3: Assaf ewes

Source: Author

One copy of the FecB allele increases ovulation rate by 1.2 ova shed per ovulating ewe and the prolificacy by 0.6 lambs born per lambing ewe (Piper et al., 1985).

The advantage of a major gene is the possibility of introducing it to any new breed while retaining the positive characteristics of the local breed (Davis, 2005). The consecutive back-crossing in this breeding program had thus the aim of minimizing negative genetic effects of the Merino, gaining the positive effect of an increased prolificacy although preserving the good adaptation of the local Awassi. Gootwine et al. (2008) reported a prolificacy of 1.92 LB/EL for BB ewes of this new Afec Awassi line (Afec).

Figure 5 shows the development from Booroola Merino, over F1 to the Afec Awassi and Figure 6 an example of an Afec Awassi hogget (B+), introduced to a Bedouin flock in the Negev.



Source: (Gootwine et al., 2000)

Figure 4: Breeding plan for the introgression of the Booroola gene into the Awassi

Source: Gootwine (2006)

Figure 5: BB Merino, F1 and Afec Awassi

Source: Author

Figure 6: Afec Awassi hogget

2.3.1 Performance of Awassi lines

The performance of the Unimproved (or local) Awassi was described by many authors (Epstein, 1977, 1982, 1985; Finci, 1957; Mason, 1967) for Awassi in Israel, in Syria (Kassem et al. 1989; Fadel et al., 1989; Kassem 1998), in Jordan (Kridli et al., 2001; Taba'a et al. 1998; Taba'a, 1999) and in Turkey (Gürsoy, 1980, 1992; Pekel, 1973; Sömnez and Kizilay, 1972; Yarkin et al., 1963). The breeding nucleus for the Improved Awassi in Israel's Kibbutz "Ein Harod" and its performance was described by Epstein (1985), Epstein and Herz (1964), Goot (1966) and Gootwine and Pollot (2000), and the Assaf breed by Epstein (1985), Goot (1986), Gootwine and Goot (1996) and Gootwine and Pollot (2000). Less performance data is still available for the Afec Awassi breed, given by Gootwine (1995, 2006, 2008) and Gootwine et al. (1992, 1995, 2001, 2006b, 2008). Table 4 gives an overview on main performance traits of these Awassi lines.

Performance data of the Afec Awassi were only generated under intensive farm conditions so far, with high input of feed and labour. Higher labour input in postnatal lamb care is named as crucial factor for the success of the FecB gene introduction. However, based on modeling Gootwine et al. (2001) suggested an increase in profitability also for semi-extensive and semi-intensive farms in Israel by introducing the FecB gene into the local Awassi, present in Bedouin flocks.