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# Beekeeping and honey production sector review and situation analysis in the Kingdom of Saudi Arabia

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## **Executive summary**

Beekeeping and honey production is a well established agricultural activity in KSA. Approximately 10 000 rural households are managing an estimated one million local bees and over one million imported bees. Beekeeping serves as source of income and a means diversifying livelihood strategies. It also creates self-employment opportunities for thousands of citizens at the different stages of the beekeeping and honey value chain. The total annual honey production in the country is 2 500 to 2 600 tonnes. Honey is deeply rooted in the Saudi culture and religion and as a result there is always a high demand. Given this demand, locally produced honey is 10 times more expensive in KSA than honey sold in Europe and the United States of America. There is a particularly large gap, estimated at over 20 000 tonnes, between the supply and demand for honey in the country. Given this situation, the main goal of the sector review was to investigate how the demand for honey can be met by incrementally increasing local honey production.

The report prepared for the SRAD Programme notes the importance of developing the beekeeping sector in reaching the goals for diversifying the country's economy as expressed in Vision 2030. Progress toward developing the sector can be made by increasing the institutional support for beekeeping extension services, conducting research, and providing training for beekeepers and extension staff at different levels. It is important to not only increase support for traditional production methods but to modernize the sector to reach a sustainable commercial business scale. The report provides an overview of the beekeeping practices in KSA. It looks at local-style hives and modern hives; the types of bee races that are used; and the ways the colonies are managed, with a focus on migratory bee-keeping practices. Honeybee forages are given particular importance, as they are the foundation for successful beekeeping. The report also takes into account the different types of honey, their quality, marketing and prices, and consumption patterns.

The report draws attention to the opportunities and challenges that faces the beekeeping and honey production sector, as well as the sector's strengths and weaknesses. One of the main areas of concern for the sector is the importing of exotic bees, which can introduce pests and diseases to local bees. It is strongly recommended that KSA become self-sufficient in the production of local honeybee colonies by strengthening local bee queen rearing capacities. Product diversification presents opportunities for the sector, as there is high demand from knowledgeable consumers for a range of high-quality honey products.

Major challenges to the sector include: the low level of improved beekeeping technology; limited forage due the effect of climate change; the limited skills and knowledge of beekeepers; the presence of diverse bee diseases; lack of access to markets for small-scale beekeepers; the mislabeling of imported honeys as local honey; deforestation; and the lack of technical support.

The report makes the following recommendations:

- Increase the knowledge and skills of beekeepers through needs-based training;
- Apply a problem-oriented approach to honeybee research;
- Adapt improved beekeeping technologies and good practices;
- Encourage genuine producers and suppliers to minimize honey adulteration;
- Improve the incomes of rural beekeepers by diversifying the range of bee products and adding value to these products; and
- Develop and diversify the supply of sources for local honeybees.

## **1. Introduction**

The report provides a comprehensive review and analysis of the status of the beekeeping and honey production sector in the Kingdom of Saudi Arabia (KSA). The report has been prepared based on a comprehensive review of the available pertinent literature (reports and published study results) and also on the conduct of short surveys that included professional field observations, stakeholder meetings and group discussions, and interviews with key informants using a checklist. In the situation analysis, six beekeeping potential target regions, 17 sample governorates and 7 beekeepers' cooperatives were visited. A total of 110 individuals (beekeepers, honey traders, members of the cooperatives, honey dealers, input suppliers, extension workers, the respective regional and governorate representative staff of Ministry of Environment, Water and Agriculture) were met. Among the individuals, 50 beekeepers representing different categories: smallholders, medium to semi-commercial beekeepers with local hives and modern box hives, and beekeepers managing local bees and imported bees were met and their colony holding size, by hive and bee race type and average honey yield by hive type recorded. Moreover, pertinent government institutes (Universities, Agricultural research, and training centers) and several private companies involved in beekeeping-related businesses (bee products processing, importing, packing and input supplying) were visited. In addition, seven queen rearing stations were visited and their current status, in terms of facilities and their operational capacities, was assessed. Moreover, different honey marketing outlets were visited. A total of 31 stakeholder meetings, interviews, and group discussions were made using checklists.

The report consists of 16 subsections and it begins with an introduction to the sector highlighting an overview of beekeeping in the KSA. It also briefly presents the current global honey production, import, and export share of major countries and the position of Saudi Arabia in the global honey market. The document further discusses the major types of honeybee races found in the country with their merits and demerits, and the challenges associated with the importation of exotic bees.

The current beekeeping practices of the country in relation to types of technologies used, the dominance of traditional beekeeping practices and their low productivity, and the importance of transformation into modern beekeeping practices are discussed. The importance of designing and adopting box hives based on the biology and morphology of the local bees and environmental conditions is also discussed. Moreover, the dominant migratory beekeeping practices and their relative advantages and associated challenges (overstocking and resource competition) and possible intervention approaches are presented.

The report discusses the honeybee forage status of the country, indicating the deterioration of the bee forage landscapes and the importance of emphasizing large-scale establishment of forage crops, and integration of beekeeping with ongoing rehabilitation and natural resource management efforts of the country. Moreover, in the report the annual local honey production volume by region, and major honey types by their botanical origins, consumption patterns, honey marketing outlets, the gaps between honey demand and supply, and variations in honey prices are discussed. In addition, the challenges of honey quality, adulteration and testing facilities are discussed. The absence of bee products diversification and value addition are highlighted as important gap areas.

Major honeybee pests, predators and diseases of the country and means of minimizing their effects through focusing on prevention measures (biomechanical means) and IPM approaches, rather than by chemotherapy are underlined. Moreover, the effects of application of agrochemicals on honeybees and their products and the importance of having coordination and early warning systems, are emphasized.

The report also identifies the major stakeholders of the sector along the value chain and discusses their roles and responsibilities. The diversified agribusiness opportunities of the sector for youth and women, in terms of both products and services across the value chain are outlined, and the importance of establishing beekeeping-related agribusiness incubation centers is recommended. Further, the status of queen rearing centers and the major gaps and recommendations to address the gaps are also presented, along with highlighting the importance of selection, genetic improvement and conservation strategies of the local bee races. A review of the established legislation related to the beekeeping sector has been made and the importance of implementation, amendments, and the need for more regulations to meet the emerging issues has been suggested. In the report the major challenges and

SWOT analysis of the sector are also discussed. Finally, major gap areas of the beekeeping and honey production sector across the value chain have been analyzed and possible interventions are recommended.

## **2. Overview of beekeeping practices in Saudi Arabia**

The Kingdom of Saudi Arabia covers an extensive land area of 2 250 000 km<sup>2</sup> which accounts for nearly for 70 percent the Arabian Peninsula landmass. Most of the country is comprised of lowland plains and deserts, however there are also extensive hills, mountain chains and associated fertile valleys which are best used for beekeeping rather than other agricultural activities (Al-Ghamdi and Nuru, 2013). The Sarawat Mountains, which range in altitude between 800 and 3 000 meters above sea level and stretch for more than 1 000 km, are one of the dominant and extensive land features in the southwestern parts of the country. These mountains have diverse climates and receive relatively better rainfall in summer, winter and early spring and support the growth and flowering of a great diversity of plant species that are rich in nectar and pollen for bees. These mountain chains and their associated valleys are potential areas of the country for beekeeping. Because of this, more than 70 percent of the bee colonies in the country are reported to exist in these regions (in Al-Baha, Jizan, Makkah, Aseer, and Al-Medinah) (Al-Ghamdi, 2007).

Beekeeping is a longstanding and widely practised agricultural activity in the rural areas of the country. The written history of beekeeping can be traced back to the beginning of the seventh century. By the seventh century, the Holy Qur'an included many statements (verses) about bees, beekeeping practices and the various uses of honey as an important remedy to treat several disorders in humans (Qur'an 16: 68-69) (Giovanni, 2001).

Beekeeping is still dominantly traditional in the country in which more than 70 percent the bee colonies are still kept in local-style hives, while less than 30 percent of the bee colonies are kept in modern hives. But as the current sample survey situation analysis indicates, the trend of transforming the traditional hives into modern hives is increasing. More than 90 percent of beekeepers migrate their colonies following the flowering of bee forages in different seasons and ecologies. In the country approximately about 5 000 beekeepers are actively involved in beekeeping but according to some recent estimates, the numbers of beekeepers are over 8 000 (Driscoll, 2018).

Generally, the number of people involved across the value chain in bee farming, processing, trading, input manufacturing and supplying is much more than the number of beekeepers. Beekeeping is one of the important segments of rural economy in the country that serves as source of income generation and diversification for significant number of rural communities. On average, beekeeping contributes about 30 percent of the beekeepers' annual incomes in the country. Moreover, it contributes to the circulation of money from relatively high-income segments of urban society to relatively low-income segments of rural society through the sale of honey. The total annual honey production of the country is around 2 600 tonnes.

Honey is an important product in Saudi society culture and religion highly regarded for its medicinal and nutritional value, and the average price of locally produced honey is around SAR 250/kg which is 10 times more than the unit price of honey in the United States of America and Europe. The country is one of the largest buyers and consumers of honey in the world. The current annual average consumption amount is more than 20 000 tonnes. The country imports over 20 000 tonnes of honey annually to fill the gap in honey demand. The trend of honey importation is increasing and in 2020 the country imported 24 000 tonnes of honey. Saudi Arabia currently exports 2 000 to 4 000 tonnes of honey mainly to Gulf countries. Generally, there is a huge gap between honey production and demand which points to the need to narrow the gap by increasing the production of honey, and productivity of beekeeping in the country.

## **3. Global honey production and marketing**

During 2019, a total 1.9 million tonnes of honey were produced in the world (FAOSTAT, 2019). About 66 percent of the world honey is produced by only 10 top honey producing countries, led by China and Turkey (Table 1). The world average honey yield per colony per annum is about 20 kg. Canada is the highest in average productivity of colonies which is 50 kg/annum per colony (Melhim *et al.*, 2010). In addition to suitable

environment and improved bee breeds, countries which revolutionized the honey production are the ones adopting appropriate beekeeping technologies and practices.

Honey is a highly traded commodity and nearly 35 percent of its production is annually exported (0.7 million tonnes). The total value of global honey exports is about USD 2 billion, with China, New Zealand, and Argentina as leading countries in honey export values (Table 1). The United States of America, Germany, and Japan are the leading countries in honey import values (Table 1). Only 15 countries purchased 81.5 percent of all the natural honey exported in 2019. Saudi Arabia is the eighth top honey importing country in the world. However, in 2020 Saudi Arabia spent about USD 107 million on honey importation and the country became the fifth largest honey importing country in the world.

**Table 1. World honey production volume, export and import values in 2019**

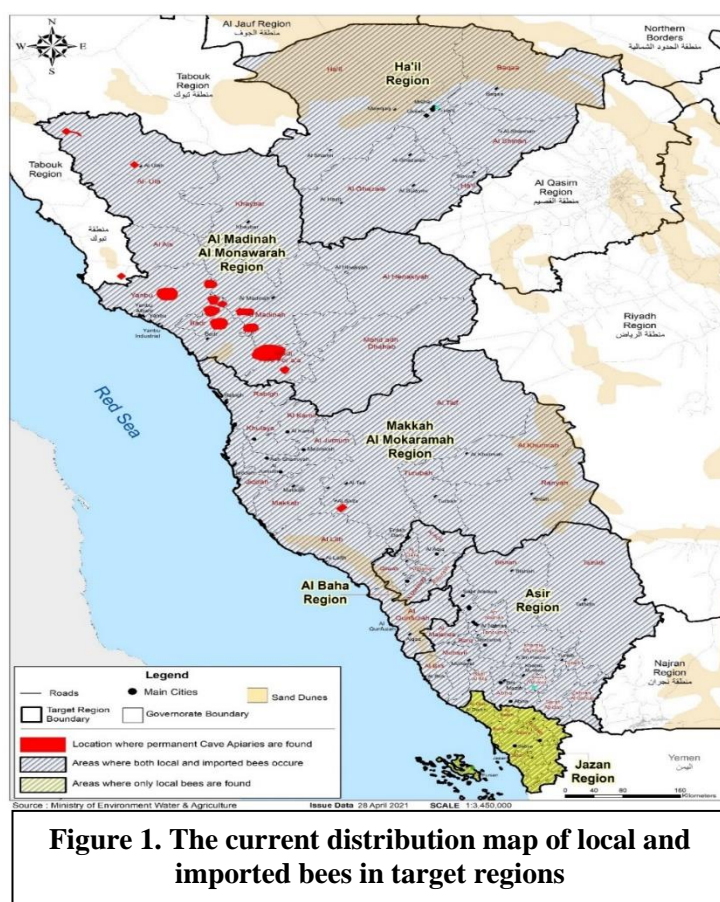
Honey production		Honey export		Honey import	
Country	Production in tonnes	Country	Export value in USD million	Country	Import value in USD million
China	497,286	China	235.3	United States	430.1
Turkey	117,044	New Zealand	228.8	Germany	249.6
Iran	78,553	Argentina	146.7	Japan	144.5
Argentina	78,188	Germany	131.5	France	118.4
Ukraine	69,491	Ukraine	113.3	United Kingdom	110.1
United States	68,352	India	99.6	China	84.9
India	68,157	Spain	92.1	Italy	82.7
Russia	66,230	Hungary	82.4	Saudi Arabia	72.9
Mexico	61,078	Brazil	67.8	Belgium	65.1
Ethiopia	50,840	Belgium	64.1	Poland	61.8

Source <https://www.worldstopexports.com/natural-honey-imports-by-country/>

Source <https://www.nationmaster.com>

#### 4. Honeybee species of Saudi Arabia

In KSA, beekeeping is practised using two types of honeybee races, the indigenous bees (*Apis mellifera jemenitica*) and an exotic hybrid of *A. mellifera carnica* and *A. mellifera lamarckii* mainly imported from Egypt. Both races are widely used in most parts of the country and the project target regions (Fig. 1).



**Figure 1. The current distribution map of local and imported bees in target regions**

#### 4.1 Local honeybee race

The total indigenous honeybee population of the country is estimated to be over one million. The indigenous bee race is well known for its excellent adaptation to the semi-arid and desert conditions of the country. The race is reported to cope well with long dry periods, brief flowering intervals, temperatures of up to 40 °C, and annual rainfall of just 50 to 100 mm (Ruttner, 1988). During the field survey in some lowland regions local honeybee colonies were observed to survive up to 50 °C summer temperatures. One of the adaptation mechanisms of the race in such semi-arid climatic conditions is by limiting its brood and adult bee population size during long dearth periods so as not to put its colony at high risk under erratic rainfall and unpredictable weather conditions of the region. Such behavior is a good survival strategy for the bees to escape the harsh period.





**Figure 2. Bees being scooped with the bare hand without showing their gentleness and low tendency to sting**

Behaviorally, the race is relatively gentle and calm without much tendency to sting even after provocation (Alqarni, 1995). During field surveys it was witnessed that bees can be scooped with bare hands without any sign of stinging (Fig. 2). Morphometrically, *A. m. jemenitica* is the smallest race of *Apis mellifera* and it is readily identifiable by its body size and yellow to grey to brown abdominal bands. However, within this population the presence of three ecological types (ecotypes) has been reported to occur in the different regions of Saudi Arabia (Al-Ghamdi *et al.*, 2012). The presence of two morphometrically distinctive honeybee populations was well noted during our field missions.

Generally, the race occupies less nest volume (20 liter) and builds 25 percent more brood cells per decimeter square than the number of cells on embossed wax foundation designed for European bee races (Nuru *et al.*, 2016). Because of its long years of natural selection, the local race is best adapted to local environmental conditions. So, emphasis should be given to improving the productivity (commercial values of the local bees) through selection breeding while targeting to conserve and sustainably use the indigenous bees rather than depending much on the importation of exotic races.

#### **4.2 Imported hybrid bees**

As result of the high price of locally produced honey, many people have become interested in beekeeping as a sideline or part-time business or as a full-time occupation. Because of their relatively cheap price and ready availability compared to that of local bees, imported honeybee colonies are in very high demand. The country imports more than one million package bees annually. In 2019 alone, the country imported 1.3 million packaged bees with a total value of SAR 130 million. The imported bees are preferred by beekeepers because of their fast establishment in box hives, comb construction, high hoarding tendency, and speed in collecting and storing nectar and even sugar syrup.

The most important undesirable trait of the imported bees is their low adaptation to the harsh environmental conditions of Saudi Arabia. More than 80 percent of the imported packaged bees die soon after the first honey harvest and the remaining 20 percent also gradually vanish in less than one year. The possible factors for death of the imported colonies could be the lack of adaptation to the new environment (the imported bees may continue to follow behavioral rhythms that are similar to those of their original homeland and the residual effect of prior environmental experience “after-effects” - which may be critical for survival of the bees in extremely different environments) result in death. The other possible factor for the death of imported bees is the lack of interest by beekeepers to maintain the imported colonies after the honey harvest when most beekeepers abandon the bees. This is because of the high maintenance cost of the imported bees in long dearth period which might be much higher or equal to the cost of purchasing new packaged bees during the flowering period. The comparative profitability of maintaining colonies over seasons versus purchasing a new colony every season must be

investigated. The imported bees may also carry and disseminate different honeybee diseases and pests in the country.

Moreover, the mass importation of exotic bees poses a high risk of genetic erosion of the indigenous bee races as result of hybridization, that ultimately would deteriorate the adaptability and disease resistance potential of the local bees. In the recent situation analysis it was noticed that there is a conflict of interest between beekeepers with local and imported bees. In some regions like Jazan and Aseer beekeepers using local bees are demanding that the government formally restrict the introduction of exotic bees to their regions. Currently, the Government of Saudi Arabia is working hard to minimize the dependency of the country on the importation of exotic bees and focusing more on mass rearing of local queens and colony multiplication to satisfy the demand for local honeybees through establishing several queen rearing and multiplication centers. Until the total banning of imported bees materialises, there should be strategy to manage the exotic bees to minimize the hybridization of the local race through delineation of areas for local bees and exotic bees, restricting the importation of drones with packaged bees, and applying strict border quarantine measures to minimize the introduction of honeybee diseases and pests.

## **5. Current Beekeeping Practices in Saudi Arabia**

In Saudi Arabia beekeeping is practised by a wide range of people living in rural and semi-urban areas as a sideline activities or as a sole occupation. Beekeeping is one of the most important economic activities for many households in rural communities. In the country around 5 000 - 8 000 beekeepers are managing about one million local, and more than one million imported packaged bee colonies. People across a range of different age groups (22 to 70 years) are involved in beekeeping, however the major proportion (76.37 percent) of beekeepers are elderly people over 40 years old, (Adgaba *et al.*, 2014) indicating the declining interest of young people in beekeeping.

The number of colonies per beekeeper ranges from as low as 5 to 3 000, with a mean of 350 colonies per beekeeper. About 25 percent of beekeepers hold less than 100 colonies, and about 60 percent of the beekeepers hold between 100 to 500 colonies, while 14 percent of them hold between 501 and 1000 colonies and only 1 percent of beekeepers holds 1 000 to 3 000 colonies (Adgaba *et al.*, 2014). The current random sample survey study showed that the colony holding size ranges from 25 - 2 200 colonies with a mean of 570 colonies per beekeeper. More than 70 percent of the beekeepers hold more than 100 colonies (Adgaba *et al.*, 2014). Generally, the average honeybee colony holding size is commercial scale. In other countries beekeepers with less than 25 bee colonies are considered as small holders, but under Saudi Arabia conditions beekeepers with less than 100 bee colonies are categorized as small holders. This is because in Saudi Arabia beekeepers with less than 25 bee colonies are few and are found very rarely. Secondly because of the low productivity of bee colonies beekeepers with less than 100 colonies collect less honey than small holder beekeepers with less than 25 colonies in other parts of the world.

According to Adgaba *et al.*, (2014) in a sample survey study conducted on all categories of beekeepers in the country, the average net annual earnings from beekeeping varied from SAR 159 007 to 334 296, and contributed an average of 30 percent to the total annual income of beekeepers. Generally, the beekeeping industry across the value chain (input supply, production and marketing) plays a significant role in increasing and diversifying the incomes of rural households and it provides a means of self-employment opportunities for several thousands of households and their family members in the Kingdom of Saudi Arabia.

### 5.1 Traditional beekeeping practices in the Kingdom of Saudi Arabia

Traditional beekeeping using local-style hives (Fig. 3) is still very dominant and widely practised by most beekeepers in the country. Currently the common and most widely used local-style hive is made in woodworking shops. It is precisely designed and assembled in cylindrical form using machine-processed timbers (Fig. 3). To construct one machine-made local-style hive, about 12 pieces machine-processed timber with dimensions of 10 cm × 100 cm) are required (Fig. 3). In the past different types of log hives made from hollowed tree trunks of different plant species were used and and now they are rarely found in some apiaries (Fig. 4). In a previous survey study conducted, about 62 percent of the beekeepers in the country use traditional hives, while 38 percent of the beekeepers use box hives. More than 70 percent of the bee colonies in the country are kept in traditional hives. However, the recent Rapid Rural Appraisal survey data showed that the colonies kept in traditional hives are gradually declining. The productivity of colonies in local-style hives is reported to be low, 3.7 kg/colony per annum with range of 0.5 to 20 kg, which is much lower than the average world honey yield of colonies (Adgaba *et al.*, 2014).



**Figure 3. A common local-style hive made from machine-processed timber.**



**Figure 4. A hollowed trunk log hive which is now rarely used by beekeepers in Saudi Arabia**

Except for the types of local-style hives which are cylindrical, traditional beekeeping practices in the country are relatively advanced and incorporate some features of box hives. Some workshops are manufacturing traditional cylindrical hives with semi-circular top bar frames to guide the bees to construct circular and regular combs that can be easily removed for both inspection of bee colonies and honey harvesting purposes (Fig. 5). Such hives are suitable for the production of comb honey. However, the dimensions of the top bar should match the thickness of combs naturally built by the local bees.



**Figure 5. Cylindrical hives with semicircular movable top bar frames to guide bees to build circular combs**

Some beekeepers prefer to use traditional hives because of their better insulating properties, the better match between the volume of such hives and the population size of local honeybees when compared with box hives, and the ease of stacking for transportation from place-to-place, particularly during migration of colonies. According to beekeepers, traditional hives do not require accessory equipment, are easy to manage, and the bees adapt well in local hives. In most cases in Saudi Arabia, bee colonies are kept in temporary apiaries away from homes and only a few beekeepers keep their bees in permanent apiaries.

Generally, the traditional local-style hives are not suitable to practise improved bee management practices such as: inspection of colonies internally; adjusting of volume of the hives with increase in the population size of the bee colonies at different season; control of reproductive swarming; and management of honeybee pests and diseases. As a result, the production and productivity of colonies in local hives are generally low compared to box hives. It is generally difficult to revolutionize the honey production and to advance the beekeeping sector of the country using only local-style hives. It is also difficult to narrow the existing huge gaps between the local honey production and demand using traditional hives. So, it is of paramount important to improve the production and productivity of beekeeping through large scale adoption of appropriate beekeeping technologies and better management practices, together with sufficient training to fill the skill and knowledge gaps of beekeepers across the country.

During the situation analysis, the main reasons mentioned by smallholder traditional beekeepers for not using box hives were skill and knowledge gaps, absence of training and technical support and financial limitations. So, for fast transformation of the beekeeping industries of the country, the problems of smallholder beekeepers need to be addressed and strong technical support provided.

## **5.2 Box hive beekeeping**

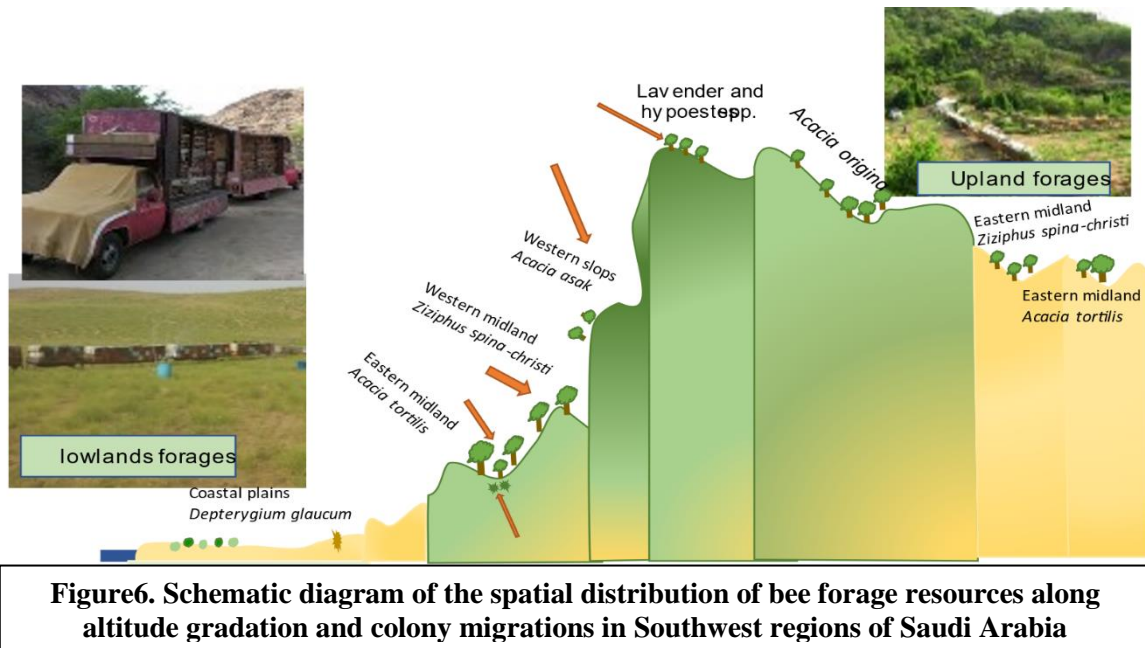
Modern beekeeping with box hives has gradually increased and 30 percent of beekeepers in the country use box hives - the recent sample survey showed the proportion of colonies kept in box hives is gradually increasing. The average productivity of colonies in box hives is about 6.5 kg/colony per annum with range of 1- 37 kg (Adgaba *et al.*, 2014). However, as shown by the recent sample survey data, the average honey yield of local bees in box hives is 7.5 kg/annum. Generally, the honey yield of box hives is twice the yield of traditional hives but still much lower than world average honey yields of 20kg/hive per annum. As noticed from situation analysis, box hive beekeepers do not use accessories (like queen excluders and others) and do not apply management practices to enhance the productivity of their colonies. They simply keep the bees in box hives but use the same management practices as for local hives. Transforming traditional beekeeping practices into improved technologies together with better management practices can significantly increase the current honey production of the country. Box hive beekeeping allows for the practice of the full range of improved beekeeping management practices to maximize the productivity of bee colonies, and it is easy to produce diversified high-value bee products such as propolis, bee collected pollen, royal jelly and others.

However, for the promotion of high-value bee products, the creation of market linkages is very important. Despite its several advantages the adoption of box hive beekeeping is very low. The possible reasons for the low adoption of box hives are: the attitudes of beekeepers who prefer to still keep local hives; low levels of technical support; lack of finance; and awareness to convince beekeepers to use box hives. The other possible scenario is that the prototype of box hive and its accessories that are adopted in the country is designed for European bees and ecologies, and does not take into account the biology and behaviour of the local bees. This generally indicates the importance of designing, testing and adaptation of box hives suitable to the local bee biology, morphology and environmental conditions which may contribute to enhance the productivity of local bees in box hives.

### 5.3 Migratory beekeeping practices

In many areas of the Kingdom, migratory beekeeping is very common and more than 95 percent of beekeepers in the country migrate their colonies. Because of the long dearth period and limited bee forages, static beekeeping is rare and does not appear to be economically feasible in the country. Seasonal shortages of bee forages and seasonal and geographic differences in bee forage availability, drive many beekeepers to move their colonies from one area to another in search of better nectar and pollen resources. Some beekeepers move their colonies for more than 1000 km from north to south and vice versa. The presence of well interconnected asphalt roads all over the country favors migratory beekeeping. Vandalism and theft of colonies are not very serious in the country, and as a result colonies can be left without having to be guarded. Migration of colonies in the country takes place mainly for two purposes. The first one is for colony strengthening mainly during the flowering of the major pollen source plants particularly in lowlands (*Tihama*) when *Dipterygium glaucum* and others are flowering. Saudi Arabia one of the challenges of beekeeping is having sufficient pollen sources which is very essential for brood rearing and colony strengthening *glaucum* is the most important pollen source species and strong colonies can collect and store large amount of pollen within a few days .Since shortage of pollen is a very limiting factor for bee colony strengthening in Saudi Arabia, it is possible to fit pollen traps to strong colonies and collect pollen that can be stored and re-used to feed colonies in dearth periods when there is shortage of pollen. Harvesting and marketing of pollen can be one area of bee product diversification in the country. In this regard, testing and adopting of pollen traps suitable to the size of the local honeybees, are important.

The other period of honeybee colony migration is for honey collection mainly during the flowering periods of some major honey source plants such as *Ziziphus spina-christi* (Sider), *Acacia tortilis* (Sumra), *Acacia origena* (Thalah), and *Acacia gerrardii* (Thalah) and many others. Since the distribution ranges of *Z. spina-christi* and *A. tortilis*, are wide, ranging from lowland to midland, there is flowering period variation between the midland and lowland plants within the same species and within the same season. So, beekeepers have a chance to move their colonies from midland to lowland or vice versa to collect honey twice in the same season from the same species of honey source plant. In some regions besides the above major honey source plants; beekeepers move their bee colonies to collect honey from *Acacia asak*, Lavender species (Durma), *Hypostes forskalii* (Mejra) and others. Generally, in some regions the frequency of migration can be nine times with an average of 3 – 6 times per annum. The schematic representation of the spatial distribution of bee forage resources along the altitude gradation in the southwest regions of Saudi Arabia is shown in Fig. 6.



Besides moving honeybee colonies for honey and pollen, beekeepers migrate their colonies to escape the hot summer in the lowlands and cold winter in the highlands. During migrations, 100 or more honeybee colonies are kept on trailers that are towed behind vehicles, allowing migration from place to place.

Although there is no established rule for keeping distances between apiaries, there is an agreed rule among beekeepers for not to keep imported bees together with local bees. In this regard, in some regions beekeepers agreed to have shared wadis (valleys) between imported and local bee colonies and the majority of beekeepers respect the agreement. However, such practices should be enforced by biding government rules. Generally, migration of colonies allows for the exploitation of resources available at different ecologies and seasons and contributes to increased production and productivity of colonies, but it also contributes to the rapid dissemination of honeybee diseases and pests all over the country. Migratory beekeeping also contributes to overcrowding and resource competition and associated declines in productivity. In general, migratory beekeeping practices, besides serving to exploit resources available at different seasons and ecologies, contribute to increasing the production and productivity of bee colonies, and also contribute to ecosystem functioning through pollination services of bees to wildflowers.

#### 5.4 Overstocking of bee colonies in forage areas

In Saudi Arabia overstocking of colonies beyond the carrying capacity of the bee forages of a given area is one of the challenges of beekeeping. Empirical studies made based on nectar secretion potential of bee forage plants in KSA have suggested a limit of around 100 colonies per km<sup>2</sup> (Al-Ghamdi *et al.*, 2016) and the world average recommendation is 100 colonies per 2.5 km<sup>2</sup> (Driscoll, 2018). However, more than 500 colonies per km<sup>2</sup> (five time more than the optimum) and associated declining of honey yield have been reported for the country (Al-Ghamdi *et al.*, 2016). Many beekeepers keep their bees without considering colony density or the actual forage carrying capacity of an area (Fig. 7). Overcrowding and resource competition within and among apiaries are major challenges of beekeeping in the country. There are no regulations, agreements or binding rules among beekeepers with respect to how much distance every beekeeper should leave between apiaries.

In an effort to address the problem of bee colonies overstocking, the Ministry of Environment Water and Agriculture (MEWA) has planned to first map and determine the carrying capacities of each valley using satellite imaging analysis and then to regulate the movement of colonies to forage areas (wadis) using smart mobile apiary tracking technology. However, the determination of carrying capacity of a given bee forage area using satellite imaging analysis should be validated with groundwork assessment. Moreover, determining the bee forage area carrying capacity (using satellite imaging analysis) and regulation of colony movement should be first done on a small scale as pilot testing in given valleys, and then expanded to other wadis based on the result of the pilot practices.



**Fig. 7. Apiaries with typical examples of overstocking about 600 bee colonies in each site with very sparsely distributed bee forages**

## 6. The honeybee forages of Saudi Arabia

Despite its arid climatic conditions, Saudi Arabia is relatively well-endowed with very diverse flora resources. Around 2 253 plant species belonging to 132 plant families have been reported to exist in the country (Collenette, 1999, Chaudhary, 2001). In the country more than 200 bee forage plant species have been identified as sources of nectar or/and pollen to honeybees. Some of the major bee forage plants are *Ziziphus spina-christi* (Sider), *Acacia tortilis* (Sumra), *Acacia origena* (Thalah), *Acacia gerrardii* (Thalah), *Acacia etbaica*, *Acacia hamulosa*, *Acacia seyal*, *Dipterygium glaucum*, *Acacia asak*, Lavender species (Durma), *Hypostes forskalii* (mejra) and others (Nuru *et al.*, 2017ab). In Saudi Arabia trees and perennial shrubs are the major sources of honey because they are less affected by erratic rainfall conditions and long dry seasons.

In beekeeping and honey production bee forage is the major governing factor in determining the production and productivity of honeybees. It is not possible to carry feeds/forages from other areas to feed honeybees a

s is done for livestock and poultry production. Despite the presence of diverse bee forage resources at different seasons and ecologies of the country, degradation of natural resources and forests, dieback of trees, regeneration gaps and declining vegetation as a result of human interferences and climate changes have been well documented in Kingdom of Saudi Arabia (NCWCD, 1998; Al-Farhan, 2000; Dawson, 2007; El-Juhany, 2009; Nuru, *et al.*, 2013). One of the factors for overcrowding of too many colonies and apiaries at short distances is due to the shortage of bee forages. In the absence of good bee forage condition of an area, skill, knowledge and technologies used, production and productivity of beekeeping will remain limited.

Hence, along with the development efforts of the government to enhance the beekeeping industry of the country, it is equally important to give concerted attention to the establishment and rehabilitation of the bee forage landscapes which are very essential for boosting the production and productivity of beekeeping and maintaining the sustainability of the sector in the long term. In this regard some pilot rehabilitation activities made at Al-Baha, (Baljarshi) have demonstrated the possibility of improving the bee forage conditions of an area through assisted restoration practices (Fig. 8).

In the FAO-Sustainable Rural Agriculture Development project, there are several Natural Resources Management activities that offer scope and opportunity to integrate with beekeeping to enhance the bee forage conditions of the country. Some of the identified areas of integration include agroforestry and livestock forage development; rehabilitation of rangelands introducing forage enclosures; vegetation cover rehabilitation and conservation practices; and integrating agro-forestry and community forestry for land degradation control. In this regard, beekeeping can be integrated and used as tool to create awareness and a sense of ownership and to mobilize communities towards rehabilitation of degraded forests and sustainable conservation of natural resources for both economic and environmental reasons. Beekeepers have to be more aware about trees and natural resources than any other ordinary people. During field missions for the situation analysis several and extensive horticultural farmlands with mango and banana orchards, and others were observed, but integration of beekeeping with horticultural crops growing is not practised. As such, awareness should be created to integrate beekeeping with growing of horticultural crops to benefit both the bees and the crops through the pollination services of the bees.





**Fig. 8. Assisted rehabilitation of degraded lands with bee forage plants (left before planting and right after 5 years)**

## **7. Honey production, types, consumption, marketing and quality**

### **7.1 Honey production and types**

The country produces on average 2.5 - 2.6 thousand tonnes of honey annually (Table 2). The major honey producing regions are Makkah, Aseer and Jazan in the order of volume produced. The local honey production satisfies only 11.5 percent of the total local honey demand which indicates the importance of narrowing the gap between production and demand. The low production volume of honey in the country is associated with the types of hive used (dominantly traditional), poor management practices and the shortage of bee forage resources. In order to boost the local honey production these problems need to be addressed.

Because of the diverse ecologies and spatio-temporal variations in growing and flowering of major honey source plants, very diverse types of mono-floral honey are produced and marketed in the country. Beekeepers in the country have good experience separating one floral honey from the other. Some beekeepers even separate different types of mono-floral honey within a single comb that have been stored by the bees at different times. Consumers in the country are very familiar with organoleptic properties of different types of mono-floral honey. Because of the preferences of consumers, mono-floral honey generally fetches better prices than poly floral honey. Every mono-floral honey has its own distinctive aroma, flavor and taste which play a great role in the subjective choice of consumers.

In the country more than 13 types of mono-floral honey are produced in different ecologies and seasons. Some of the major mono-floral honey types produced in the country include: *Ziziphus spina-christi* (Sidr), *Acacia tortilis* (Sumra), *Acacia origena* (Thalah). Lavender (Dhurma), *Acacia asak* (Dahiana) and *Hypoestes foreskalii* (Mejra) together with other types of honey which are produced in relatively small volumes in different pocket areas of the country. Sidr honey is one of the most favored types of honey in the country and is produced mainly between September to October. *Hypoestes foreskalii* (Mejra) honey is the most expensive honey which may cost up to SAR 800/kg (USD 200/kg).

### **7.2 Comb honey**

Besides the variation of honey by floral origin, beekeepers in the country produce and market both strained (liquid) and comb honey. Honeycomb is favored by consumers, and it fetches a relatively better price than liquid honey. Comb honey production is widely practised, using mostly traditional hives. Some beekeepers use traditional hives that have been designed for comb honey production with movable and semi-circular or rectangular frames (Fig. 5 and 9).

**Table 2 Honey production volumes (in kg) of KSA by region and year**

Regions	2017	2018	2019
Riyadh	14 902	10 707	13 804
Makkah	845 283	890 937	868 110
Al-Madinah	27 132	28 247	29 689
Al-Qassim	23 368	22 718	23 043
Eastern Province	3 764	3 807	3 785
Asser	674 593	681 735	778 164
Tabuk	251 956	212 843	232 400
Hail	135 000	113 091	124 045
Jazan	305 676	328 951	330 413
Najran	161 250	165 573	163 411
Al-Baha	75 072	74 026	75 549
Al-Jouf	4 000	3 465	3 732
<b>Total</b>	<b>2 521 996</b>	<b>2 536 100</b>	<b>2 646 145</b>

Source: Ministry of Environment Water and Agriculture, 2019



**Figure 9. Comb honey production**

**Processing of honey:** Most beekeepers in the country extract honey using traditional straining methods, while some beekeepers with box hives extract their honey using a centrifugal honey extractor. One of the reasons for the low adoption of modern hive beekeeping in the country is the requirement to use different accessories like honey extractors, foundation sheet making devices and others. Since many beekeepers lack honey extraction



**Figure10. L to R: Honey market places and open market; and honey auction**

facilities, establishing mobile honey extraction services will support smallholders box hive beekeepers to extract their honey easily wherever they are. The service can be promoted as one of the potential areas of agribusiness opportunity for youth. In this regard the Al-Baha and Abaha Beekeepers cooperatives are providing honey extraction and ripening services to beekeepers (using a honey dehumidifier) with reasonable service charges.

### **7.3 Consumption of Honey**

Honey is deeply rooted in the culture and religion of Saudi Arabian citizens. It is widely used for its medicinal and restorative properties and as a sweetening agent. Daily honey consumption is higher on traditional, religious and festive occasions, particularly during the month of Ramadan, when it is widely used in the preparation of evening desserts to quickly replenish lost energy after fasting. Honey is widely used in various homemade recipes. However, society believes more in the medicinal value than the nutritional benefits of honey.

Consumers commonly characterize honey quality based on its organoleptic features such as taste, aroma and flavor and by its physical state (crystal or liquid) and color (Sobhy *et al.*, 2014). In addition, the source of the honey, the brand name, and confidence in the producers highly influence the perception of consumers on quality of honey. Medication, food and sweetening are the major motivations behind buying of honey in the Saudi market (Sobhy *et al.*, 2014). Saudi Arabia is one of the top honey consuming countries in the world. The total annual consumption of honey is around 20,000 tonnes (Driscoll, 2018). Saudi Arabia is one of the top countries in the world in per capita honey consumption.

### **7.4 Marketing of honey**

The country imports annually around 20 000 metric tonnes of table honey to fill the gap in demand and in 2020 the country imported 24 000 tonnes of honey. The major source countries are Australia, Turkey, Mexico, Argentina, Pakistan, India, China, The United States of America, Germany, and Yemen (Al-Ghamdi, *et al.*, 2014, Driscoll, 2018). Saudi Arabia re-exports 2 000 - 4 000 tonnes of honey annually to Algeria, Jordan, Gulf countries and others.

The majority (60 percent) of the local beekeepers sell their honey directly to consumers based on personal communication (Sobhy *et al.*, 2014). Moreover, beekeepers sell their honey in open markets and also at auctions (Fig. 10) which are very common in the country. In the honey auction market, there are private companies facilitating the process of auction who give guarantees to the buyers for the quality of the honey they purchase. In auctions, consumers, dealers and retailers are the major buyers of honey. Beekeepers pay a 7 percent service charge from the total amount of their sales at the auctions.

Apart from the direct 'beekeepers to consumers' marketing channel, there are many retailer shops in big cities specialized in selling only honey. Imported and packaged honey with different brand names and volumes is retailed in malls, supermarkets and small shops across the country. Because of the scarcity and the direct producers to consumers channel, the locally produced honey is not generally available in retailers' shops. Besides the retailers, there are importers, wholesalers and packers distributing honey with different brand names such as Al-Shifa, Al-Asal -Al-barri and Almarai. The organization of several annual honey festivals in different regions and governorates is very common in the country and these festivals contribute to the promotion and creation of linkage and market opportunities for the producers.

### **7.5 Price of honey**

There is a large price disparity among the different types of honey within the region and within the same types of honey among regions. Generally, *Ziziphus spina-christi* (Sider) honey commands high prices across all regions, with a range of SAR 250.0 to 375.0 per kg with a mean of around SAR 300.0. *Acacia origena* (Thalah) honey price varies from SAR 200 to 300 and that of *Acacia tortilis* (Sumra) honey price varies from SAR 200 to 350 per kg. Generally, beekeepers receive SAR 50 -100 more per kg of comb honey than liquid honey, as consumers are willing to pay higher prices for such honey, which is assumed to be free of adulteration. There are also very expensive (rare or special) honeys produced locally such as *Hypostes forskalii* (Majra) the price of price is around SAR 800 and more per kg. Domestic consumers highly prefer locally produced honey over imported honey and pay five to eight times more than for imported honey. The average price of locally produced honey is 10 times higher than the average price of honey in the United States of America and Europe.

Generally, the prices paid for imported honey are much lower than the prices paid for locally produced honey and honey from Kashmir commonly sold at lower prices SAR 35 to 85 per kg. The price of imported honey from other countries (Europe and Australia) varies from SAR 100 to 400 per kg.

Factors affecting the honey pricing in the country are country of origin, botanical origin, taste, color, aroma, viscosity and packaging type (Sobhy *et al.*, 2014). The high price of locally produced honey could be related to the long-term adaptation of local consumers to the flavor, aroma, and taste of locally produced honey and these may have influenced the subjective choices of consumers for local honey. Moreover, cultural and religious values for honey in the society, its scarcity, and the relatively high incomes of middle- and upper-class consumers who can afford to buy expensive honey may have contributed for the high price of local honey. Attractive prices for locally produced honey have encouraged beekeepers to persist in beekeeping as a part-time or full-time business. Currently, there are several government initiatives and support programmes (including training, provision of startup kits, access to financial resources) for youth and women to engage in beekeeping-related business. As a result many young people are motivated to engage in beekeeping as a part-time or full-time business.

Some of the honey marketing challenges in the country include adulteration of honey that reduces consumers' confidence for honey consumption, absence of market structure, and sustainable market linkages for small scale beekeepers and the low scale of production that reduces price competitiveness.

### **7.6 Honey quality and the issue of adulteration**

In the country high quality honey from the farm gate and at retailers' shops is readily available. However, due to the high price of locally produced honey, dishonest producers or processors or sellers have a strong motivation to adulterate honey with sweeteners or to market imported honey labelled as Saudi Arabian expensive honey. Generally, as a natural product with a relatively high price, honey has long been a target for adulteration, and methods of honey adulteration and types of adulterants are becoming more diverse and complex.

To minimize the adulteration of honey and to encourage genuine producers and suppliers and to protect consumers from fraud honeys, there should be mandatory quality testing requirements and regular inspection of honey in the various market channels. Along with this, having accredited honey quality testing laboratories at different parts of the country is very important. In this regard there are honey quality testing laboratories which include: the Saudi Food and Drug Authority laboratory, Ministry of Environment, Water and Agriculture (MEWA) laboratory in Riyadh and Al-Baha Beekeepers Cooperative's laboratory at Buljarshi. There are also privately owned laboratories in Riyadh that test honey quality such as the Jawdat Aasal and Saudi Ajal laboratories. However, inconsistencies in honey laboratory test results (Driscoll, 2018) have been reported. This indicates the importance of having national honey quality testing procedures and protocols that comply with the international standards and that can be applied in all testing facilities in order to have consistent test results across the country.

Alignment of the physicochemical quality test parameters with melissopalynological analysis would be very important to detect the geographical and botanical origins of honey and to protect the locally produced honey from mislabelling and blending with imported honey. Besides the physicochemical quality parameters, there should be a test for checking the accepted residue levels of agrochemicals, antibiotics and any environmental contaminants in honey for both locally produced and imported honey following the Hazard Analysis Critical Control Point standards.

### 7.7 Beeswax production

Beekeepers in Saudi Arabia harvest only honey. The readily available byproduct of honey, beeswax that has more than 300 uses and fetches a good price, is not commercially collected and utilized. It is possible to harvest beeswax at rates of 1 percent and 10 percent of the honey produced from box and traditional hives respectively without requiring additional inputs. Since more than 50 percent the colonies in the country are kept in traditional hives, the amount of beeswax that can be obtained from traditional hives is very significant. However, the product is wasting at different levels (Fig.11) due to lack of awareness. Once beeswax is processed (Fig 12) it can be kept for many years without deterioration in quality. Due to lack of collection and utilization of locally available beeswax, the country annually imports a large volume of paraffin wax foundation sheets for box hive beekeeping. Currently, the Abaha, Rajal Alma and Al-Baha Beekeeper's cooperatives are purchasing crude beeswax from beekeepers and reselling to processors, which is a good start to encourage beekeepers to collect and sell the crude beeswax.



**Figure 11. L to R: Discarded beeswax and processed beeswax**

### 7.8 Other high value bee products

In the country high value and readily available primary bee products (other than honey) such as pollen, propolis and royal jelly are not collected and utilized. The country imports large volumes of bee collected pollen and royal

jelly annually from China. In 2020 Saudi Arabia imported 800 tonnes of natural honey rich with royal jelly for about SAR 15 million. The Saudi consumers are aware of the nutritional and medicinal value of pollen and royal jelly and purchase them at very high prices. So, training, awareness and pilot demonstration of the production and marketing of high-value bee products are very important to encourage beekeepers to become involved in the production of high-value bee products, and so increase and diversify their incomes.

## 8. Honeybee pests, predators, and diseases in the Kingdom of Saudi Arabia

Different honeybee pests, predators and diseases are reported to exist in the Kingdom of Saudi Arabia. The major reasons for the occurrence of pests and diseases could be due to the importation of large numbers of packaged bee colonies annually without having proper quarantine systems to check whether the imported bees are free from disease and pests. The other possible reason is due to the extensive migratory beekeeping practices in which 95 percent of the beekeepers in the country migrate their colonies from place to place. Overstocking of too many colonies within apiary and absence of optimum distances among apiaries may have also contributed to the rapid dissemination of various honeybee diseases and pests in the country.

### 8.1. Honeybee pests and predators

As in many tropical and subtropical regions, honeybee pests and predators are more serious than honeybee diseases in Saudi Arabia. Some of the major honeybee pests and predators found in the Kingdom of Saudi Arabia include different wasp species (hornets and beewolf), wax moths and bee-eater birds and are the major threats to the honeybees both in their degree of damage and area of coverage.

#### Bee-eater wasps

There are two species of wasps that attack honeybees in Saudi Arabia. The first one is the Oriental hornet (*Vespa orientalis*) which is a social insect living in a colony. *Vespa orientalis* contributes to weakening and total absconding of bee colonies. *Vespa orientalis* makes its nest in hidden places and reproduces in the thousands. The adults are very notorious prey on different insects including honeybees. They attack individual bees outside the hive and invade beehives and eat all stages of bees (adult, pupae and larvae) and stored pollen and honey. The attack of the *Vespa orientalis* eventually leads to dwindling and absconding of the whole colonies. There are some mechanical methods like mesh and adhesive glue using luring materials to trap and minimize the attacks of the hornets around apiaries. The local bees (*Apis mellifera jemenitica*) have very strong nest defensive behavior against *Vespa orientalis*, narrowing their hive entrance and making a 360° defense line to protect their nest from the wasp attack in all directions (Fig.12).



**Figure 12. Defensive behavior of the local bees in protecting their nest from oriental hornet attack**

Another type of wasp which attacks honeybees in Saudi Arabia is the Beewolf (genus *Philanthus*). It is also known as bee-killer wasp which mostly preys on honeybees. It is widely found in lowland plains of the country. Beewolves are more dangerous to honeybees and they peak and carry away the adult bees instantly mainly at their hive entrance.

### **Wax moth**

Both the greater wax moth (*Galleria mellonella*) and lesser wax moth (*Achroia grisella*) are infesting honeybee colonies in the country. Because of the warm environmental conditions of the country, wax moths are very common honeybee pests and they damage combs in a hive and eventually lead to absconding of colonies. Wax moths infest mostly weak colonies with an unattended comb by the bees. Only the larval stages of wax moths attack honeybee combs. The wax moth larvae damage the beeswax combs making tunnels and silk webs throughout the comb feeding on pollen, honey and larvae debris. Wax moth can be easily controlled with proper seasonal management of bee colonies through removing combs not covered by bees in both local and box hives.

### **Bee eater birds**

Bee eater birds (*Merops persicus*) are economically important honeybee predators in Saudi Arabia. The bee eater birds are migratory and gregarious and appear two times in a year in April to May and also in October to November during their migrations from North to South hemispheres and vice versa. During their appearance, they invade an apiary in mass and interrupt the normal foraging activities of the bees. Each bird eats a large number of bees in a day at a rate of up to 400 bees per bird (Driscoll, 2018). The birds also eat virgin queens during mating flights and reduce the success rate of virgin queen mating. There is no effective means of controlling, except stretching net in front of apiaries and making loud noises to temporarily chase them away.

## **8.2 Honeybee diseases and agrochemical spray**

Serious honeybee diseases such as American foulbrood and European foulbrood are not common in the country. The major honeybee diseases found in Saudi Arabia include Varroa mites, Chalkbrood and Nosema.

**Varroa mite (Varroa destructor):** Varroa destructor is one of the most economically important honeybee diseases in the KSA both in terms of area coverage and damage to honeybee colonies. The wide spread of the disease is associated with extensive importation of packaged bees and migratory beekeeping practices. Beekeepers in the country use Apivar strips to control the varroa mites. Some studies reported that the indigenous bees (*Apis mellifera jemenitica*) have relatively better tolerance to Varroasis (Alattal *et al.*, 2017).

**Chalkbrood:** Chalkbrood is one of the economically important honeybee diseases in the KSA and it is caused by a fungus called *Ascosphaera apis*. It is the most contagious honeybee brood disease without reliable chemotherapy. The only treatment available is to discard the infested combs and replace with new wax foundation sheets or total burning of the infested hives together with the combs and the frames.

**Nosema disease:** Nosema is an adult honeybee disease caused by spore forming fungus called *Nosema ceranae* and *Nosema apis*. It is reported to occur widely in the country and beekeepers are using chemotherapy (Fumagillin) to treat the disease. However, its impact on local honeybee health status under local environmental conditions is not yet well studied and documented, and it would be important to know the economic importance of the disease and the impact of using the chemotherapy.

**Honeybee diseases and pests control measures:** Generally, to minimize the infestation and dissemination of honeybee diseases within an apiary, it is better for beekeepers to apply prevention, IPM and biomechanical treatment measures than focusing on chemical treatments which are not recommended, to avoid the contamination of honey with chemical residues. In case of varroasis treatment, interruption of the development life cycle of the varroa, through creating non-brood periods in a colony and in case of chalkbrood infestation,

destroying of highly infested combs and replacing with new combs or total destroying of infested hives, are good examples of biomechanical treatment of honeybee diseases. Establishment of a strong border quarantine systems to halt the introduction of various honeybee diseases and pests, together with the importation of live bees and used equipment and making regular surveillances of disease occurrences, will be useful to control honeybee diseases in the country. Moreover, raising of the awareness of beekeepers to minimize chemotherapy and focus on integrated pest management and biomechanical approaches would be very useful.

**Agrochemical spray:** In Saudi Arabia, since honeybee colonies are mostly kept away from villages and farmlands, the effect of agrochemicals on the death of honeybees is relatively low. However, relatively high deaths of bee colonies have been reported during the spraying of pesticides against desert locust, which is a very common occurrence in the country. Chemical spray not only kills the bees but it may also contaminate the honey and beeswax and this may also affect the health of humans. Beekeepers are concerned about the lack of an early warning system and respective coordination with them during chemical applications. To minimize the death of honeybee colonies, coordination among concerned authorities and providing early warning to beekeepers to move their colonies to safe places, are very important. Moreover, registration of beekeeper's colonies and apiaries with mobile tracking system to recognize and protect the bees during chemical spraying is an important measure. Beekeepers have been observed to erect a long pole with red cloth on it around their apiary as a signal during aerial spraying of chemicals. In this regard it is important to establish and implement strong regulations on safe application of agrochemicals. Moreover, implementation of honey chemical residue monitoring schemes will be important to control the degree of honey contamination with chemical residues.

## 9. Beekeeping and honey production sector stakeholders

The beekeeping and honey production sector involves with several tiers of stakeholders. The sector's stakeholders can be generally categorized into two major groups: primary and secondary stakeholders. The primary stakeholders are those who have key interest or have power and influence in the sector. The secondary stakeholders are the ones either having no strong interest or having interest but no power to influence the sector.

### 9.1. Some of the primary stakeholders of the sector

**Input suppliers:** Inputs are important to start and to efficiently run the beekeeping and honey production business. The major input suppliers in the sector include, the packaged bee importers and distributors, box and local-style hive manufactures, bee equipment importers and distributors, supplementary bee feeds and medicine importers and distributors. Some of the major beekeeping input supplier entities in KSA are Al-Baha Beekeepers Cooperative, Al-Mohaidib company, Dohia Al-Nahl Est., Lawazim Al-khaliah and others. As has been observed in the situation analysis, there are unregistered imported inputs such as honeybee feeds, medicines and substandard equipment that are available in different input suppliers' shops. Moreover, in the country there is no standard for modern hives and frames based on the biology of the local bees. To protect the industry, having appropriate standards and regulatory frameworks are important to regulate the qualities of imported and locally produced inputs.

**Beekeepers (producers):** In Saudi Arabia besides the variations in colony holding sizes there are different categories of beekeepers with different levels of interest. Some of the segments of beekeepers include: those keeping local bees in local hives; those keeping local bees in box hives and those keeping imported bees mainly on a seasonal basis. The latter group buys imported packaged bees only during the flowering periods of some specific honey source plants, and they abandon the bees after honey harvest. Such types of beekeepers are not dedicated, and they are working to get quick profit. In addition, some of the beekeepers are fulltime beekeepers while others are part-time beekeepers together with other occupations. There are also beekeepers who are migratory and while others are stationary beekeepers in which the latter group is less than 10 percent of the total beekeepers. Beekeepers can be also categorized based on their colony holding sizes (hobby beekeepers (< 25), smallholders (25 - 100) and semi commercial and commercial above 100). Depending on colony holding size,



70 percent of beekeepers in the country are semi-commercial to commercial. These groups of beekeepers look for marketing channels to sell their honey. Some of the beekeepers in Saudi Arabia have their own honey shops in their respective governorate town and some collect honey from other beekeepers and resell.

Generally, most beekeepers have common interests in terms of fighting honeybee diseases, reducing chemical sprays and improved forage availability. However, in relation to technology adoption, access to services, resources and markets, different categories of beekeepers have different challenges and interests. There are clear conflicts of interest between beekeepers with local and imported bees because beekeepers with imported bees are not dedicated and focus only on making quick money. The extension or development intervention approaches of MEWA should address the interests of the various groups differently. The training given to beekeepers with local bees in local hives should be different from beekeepers with local bees in box hives or imported bees in box hives because colonies in different hive types require different management approaches depending on the types of technologies used. Moreover, the skill and knowledge gaps and interests of different beekeepers' groups are different and have to be handled differently.

**Processors/Aggregators:** There are honey processors/aggregators that collect honey from primary producers and intermediary dealers. The aggregators refine, pack, and distribute to honey shops, malls, and supermarkets. There are also dealers that collect honey from micro and small producers and act as intermediary dealers with either consumers or wholesalers at their forward end. The value addition made by processors include fine refining and filling in different sizes of retailing jars and labelling attractively to appeal to consumers. Some processors have their own honey shops and online markets to sell their honey locally and abroad. Some beekeepers' cooperatives such as Al-Baha Beekeepers' Cooperative are involved in collection, processing and retailing of locally produced honey.

**Retailers:** Every mall, supermarket and food grocery in the country is retailing honey. In addition to these there are more than 350 honey retailer shops in big cities and towns across the country which are dedicated to selling honey only. The retailers sell both locally produced and imported honey.

**Honey importers, packers and distributors:** There are big companies like Al-Shifa, Jamjoom and Almaria that import large volumes of honey in bulk. These companies reprocess, pack and distribute to local retailers and also re-export to different countries. Al-Shifa exports to more than 40 countries across the world. Although the imported and locally produced types of honey have their own different market segments, large scale importation of honey may affect the long-term demand and prices of locally produced honey.

**Consumers:** In the beekeeping and honey production value chain, the major goal of beekeeping is production of honey which is a cash commodity mainly produced for marketing purposes. As a result, consumers are the main drivers of the value chain. Thus in the development of the honey value chain, it is primarily important to satisfy the consumers' demands and establish trust in the bee product while building awareness on nationally produced bee products.

Honey is a highly prized product in the religion and culture of Saudi Arabia societies regarded for its medicinal and nutritional values and there is strong demand. For sustainable development of the sector, it is very important to meet the expectation of the consumers. In the KSA, consumers generally perceive that locally produced honey is inconsistent in quality as result of adulteration or mislabeling of imported honey as locally produced honey. Hence, quality assurance is mainly based on direct relationships created between consumers and producers and buying from specialty honey shops who have established reputations. In order to build consumers' trust, establishing honey quality testing laboratories in different regions, development of MEWA's certified authenticity label (quality mark), mandatory quality testing and regular inspection for quality of the product will be useful to build consumers' trust. Moreover, branding of honey and establishing Geographical Indications (GIs) for special Saudi honeys will be useful to protect the local honey and to build consumer trust.

**Government bodies:** The Ministry of Environment Water and Agriculture (MEWA) is one of the top important government bodies that has high interest in the development of the beekeeping sector. As a government body,

MEWA has strong interest to increase the production and productivity of the sector sustainably and thereby improve the incomes of rural beekeepers and create more jobs for youth and women in the sector. The major role of the MEWA is that of providing regulatory services and law enforcement, regulation and licensing to protect and support the sector as whole. One of the regulatory services that is currently underway is the national registration of beekeepers and their apiaries using digital mobile applications. The registration is important to get better statistical information on the number of beekeepers, number of colonies and to guide beekeepers on the movement of colonies to optimize the carrying capacity of bee forages at different seasons and in different valleys (wadis). Moreover, the information can be used in early warning systems for spraying of chemicals. During the situation analysis it was noticed that many beekeepers do not know how to register on the website launched for this purpose.

MEWA, in collaboration with other concerned authorities provides regulatory services and certification in beekeeping-related imported and exported items such as bee products, bee equipment, live bees, supplementary bee feeds and medicines. MEWA is currently in the process of launching a quarantine system to prevent the introduction and dissemination of honeybee diseases and pests into the country. In addition, it is also in the process of launching a mobile veterinary clinic to treat honeybee diseases in major beekeeping areas of the country. MEWA is also developing a mobile application system to assist beekeepers to easily identify honeybee diseases and pests and to take necessary management actions or request assistance through call-in services. MEWA plays a great role in increasing the skills and knowledge of beekeepers in organizing different levels of beekeeping training and it has allocated significant budgetary support for conducting training all over the country. However, the quality and the impact of the training should be properly assessed. Currently MEWA together with Saudi Arabia Council of Cooperatives is providing training for 1 500 youth and women to become involved in beekeeping related agribusinesses.

MEWA has established queen rearing centers in different regions of the country with the aim of multiplying and distributing local honeybee queens to satisfy the local honeybee colony demand. However, at this stage the centers lack qualified staff and optimum facilities to effectively run the queen rearing activities.

Through MEWA, the Agriculture Development Fund and the Small and Medium Enterprises General Authority (Monsha'at) are working collaboratively to support youth and women to develop skills in beekeeping and entrepreneurship training to open their own beekeeping related agribusinesses (bee farm, bee equipment manufacturing, queen rearing, bee products diversification and so on). MEWA under the Secretariat of Environment is doing a lot to conserve and rehabilitate the degraded lands and forests. The rehabilitation and conservation programme should be integrated with the development programme of beekeeping. Integration of beekeeping with the rehabilitation program would be one of the innovative ways of rehabilitation and conservation of natural resources with the involvement of beekeeping communities. Generally, the immense support of the government to the sector is a great opportunity to enhance the development of the beekeeping and honey production sector of the country.

**Universities:** The universities are important stakeholders in the beekeeping and honey production value chain in supplying qualified professionals to the sector. King Saud University has contributed significantly in training post graduate students and conducting several research studies and publishing the findings. The King Khalid University (Honeybee Research Unit) is currently involved in several activities, research, extension services and training. In collaboration with Saudi Aramco, the Unit is providing diploma training on beekeeping. Since one of the gaps in the beekeeping industry of the country is lack of skilled and qualified manpower, universities in the country should have a unit to train young Saudis from Diploma to Bachelor level in Apiculture. Such graduates after 2-3 years of service in the sector, and based on their dedication and interest, can be provided with further education (abroad) to produce long term competent professionals in the sector. The current situation analysis study revealed that despite the presence of many universities in the country that are involved in apicultural research, problem-oriented, demand-driven and applied apicultural research in the context of local conditions is lacking.

**Beekeeper’s cooperatives/associations:** In Saudi Arabia there are number of beekeepers cooperatives operating in different regions of the country (Table 3). In some regions such as Aseer, there are two cooperatives (Abha and Rajal Alma). Some of the cooperatives like the Al-Baha, Nahal and Rajal Alma are stronger than others. Generally, the cooperatives play an important role in organizing training, market promotion through preparing honey festivals, supplying beekeeping related inputs and honey quality testing services, and creating markets for bee products like beeswax and bee collected pollen. Some cooperatives like Al-Baha and Abha are providing honey ripening services for their members and non-member beekeepers. Apart from these services, the associations play a role in giving the individual beekeepers a voice to get support and to solve some of the sector’s common problems. One of the limitations noticed from situation analysis is that the beekeepers’ cooperatives comprise only very few beekeepers in the country.

Table 3. Beekeepers’ cooperatives and their regions

#	Name of the beekeeper’s cooperative	Regions	Remarks
1	Al-Baha Beekeepers Association	Al-baha	
2	Abha Beekeepers Association	Aseer	
3	Rijal Alma Beekeepers Association	Aseer	
4	Jazan Beekeepers Association	Jazan	
5	Taif Beekeepers Association	Taif	
6	Makkah Beekeepers Association	Makkah	
7	Nahal Beekeepers Association	Riyadh	
8	Medina Beekeepers Association	Medina	
9	Najran Beekeepers Association	Najran	Under registration
10	Al-Qassim Beekeepers Association	Qassim	
11	Al-zulfi Beekeepers Association	Riyadh	
12	Hail Beekeepers Association		Under registration

Apartt from the above stakeholders, there are many organizations that support or are linked to the sector. Examples of such organizations include, quality testing laboratories, financial organizations (Agriculture Development Fund), packaging companies, wholesalers and retailers of honey.

## 9.2 Some of the potential local partnerships and areas of collaboration

Among the listed stakeholders and others there are potential partnerships and opportunities to the current beekeeping and honey production component (FAO-SARD). Some of the potential partnerships and their opportunities are briefly presented below.

**Apimondia:** One of the potential partnerships to the “Beekeeping and honey production component” will be Apimondia. Apimondia is an “International Federation of Beekeepers’ Associations” that promotes scientific, ecological, social and economic apicultural development in all countries in the world since 1897. The organization consists of seven scientific commissions and five regional commissions representing each continent.

The organization is also working collaboratively with the FAO. Some of the thematic areas of the Apimondia where the bee component can create partnership with organization include: conservation and sustainable use of biodiversity for food and agriculture; support for young people's empowerment and provision of skills and green jobs opportunities through beekeeping; promotion of the broadening of pollinator biodiversity; improvement of pesticide regulations and utilization through raising awareness of governments, general public, and civil society; assessment of current and future environmental scenarios for bees and other pollinators and work to ensure ecosystem services; fostering and promotion of better understanding on the potential of beekeeping for rural and social development; and implementation of good beekeeping practices for sustainable production and improved livelihoods.

**King Khalid University:** The King Khalid University (KKU) is one of the potential organizations to create partnerships with the Beekeeping and honey production component of the (FAO-SRAD) project. KKU has a "Bee Research Unit" which is under the College of Community services. The unit has seven qualified staff working in different disciplines and currently the unit is involved in queen rearing, training of beekeepers (youth and women and beekeepers), extension services, and conducting various beekeeping research. In the beekeeping and honey production component there are many issues that need to be verified. For instance, there are no tangible figures on productivity of local bees in different hives in comparison with imported bees. Moreover, there are important improved beekeeping technologies and practices that need to be tested for their suitability to local bees and environmental conditions before demonstrating and adoption by beekeepers on a large scale. In this regard, KKU would be a potential partner to work collaboratively to test and verify some of the potential improved beekeeping technologies and practices.

**Al-Baha Beekeepers' Cooperative:** The Al-Baha Beekeepers' Cooperative is one of the more successful beekeepers' cooperatives in the country. The cooperative is actively working in area of training, input manufacturing and supplying, honey quality testing, market promotion, queen rearing and collecting, and processing and marketing of honey. The cooperative is one of the potential organizations to create partnerships with the bee component in areas of training, queen rearing and technology pilot testing and demonstration and establishing beekeeping related agribusiness incubation centers.

## **10. Agribusiness development opportunities in beekeeping and honey production sector**

In the beekeeping and honey production value chain, there are several agribusiness opportunities. Some of the agribusiness opportunities include establishment of bee farms and production of honey and other bee products (particularly for youth). In addition, production, collection, and value addition of high value primary bee products such as pollen, propolis and royal jelly are some of the agribusiness opportunities of the sector. These products are widely used to produce cosmetics and various nutrient-rich healthy foods. In this regard the Saudi consumers are very much aware of such products. In 2020 the country imported 800 tonnes of royal jelly rich natural honey with a value of SAR 15 million.

Since the country imports more than 1 million packaged bees and queens annually, rearing and supplying of local queens and packaged bee colonies is one of the important areas of agribusiness with very high future prospects to substitute the importation of exotic packaged bees and queens. In addition, manufacturing of improved, affordable and appropriate bee hives (suitable for smallholders, local bees and conditions), beekeeping tools, equipment and bee protectives, beeswax foundation sheets and preparation and supplying of suitable supplementary honeybee feeds would be important areas of beekeeping related agribusinesses.

Moreover, collection, processing and packing and marketing of honey and, value addition of honey and its by-products are some of the important areas of agribusiness in which women could be involved. Beeswax and other bee products are important natural ingredients to produce high-quality beauty and body care products that can be potential agribusinesses for youth and women. Moreover, production of natural and healthy foods and traditional/indigenous agri-foods using honey as an ingredient can be potential agribusiness opportunities for

women. In this regard, the Saudi society is very conscious of the health and nutritional values of foods and have high demand and are willing to pay attractive prices. However, it requires strong awareness creation at the consumer level and promotion of markets at large for such products. Taking advantages of e-marketing opportunities, women, disabled persons and youth can establish and sustain beekeeping related small agribusiness (cottage industries) without the need for fixed establishments or retail shops.

In addition, providing services such as: mobile honey extraction and straining, transport of colonies during migration, providing different levels of training and other services can be potential business opportunities for young people in the country. Given the importance of the honey value chain in the economy and life of a large number of stakeholders, providing support for agribusiness opportunities for youth and women across the value chain will bring long term and sustainable benefits for the country. Hence, the establishment of a beekeeping and honey production agribusiness incubation centre in an appropriate location, to be managed by an appropriately owned and operated business incubator is highly recommended.

## **11. Queen rearing and colony multiplication centers**

The Kingdom of Saudi Arabia envisages to become self-sufficient in local honeybee colony and to gradually stop the importation of exotic bees. To achieve this goal, the MEWA has planned to strengthen the existing queen rearing centers and to establish four new centers (Table 4). During the situation analysis, the bee component team visited the existing queen rearing centers found in the different parts of the project target regions. The details on the status of each assessed queen rearing center, the available facilities, operational status, strengths, limitations, and measures (recommendations) to be taken for improvement are provided in separate report. For simplicity of this report, centers with similar current status are clustered and briefly presented in two categories below.

The queen rearing centers like Riyadh, Al-Qassim, Taif and Al-Baha were originally built for the purpose of rearing and distribution of queens more than 25 years ago, but remained without showing significant progresses. The other queen rearing centers such as Rajal Alma, Abha, Jazan, Al-Medina and Hail were originally built as beekeeping demonstration and training sites and have been recently assigned to serve as queen rearing centers.

The queen rearing centers under category 1 include the Al-Baha, Taif and Jazan and the centers under this category have at least some limited facilities such as shelter for the bees that can hold up to 100-200 bee colonies, and all have at least small rooms with different sizes for grafting, office, store and living room (for one worker). Regarding manpower, except for low-level technicians who attend to the bees, all the centers have no qualified technicians or experts. The queen rearing centers under this category can start operating the queen rearing activities with available facilities with some limited additional inputs. They require mainly optimum skilled and qualified manpower and grafting facilities to rear and supply queens.

The second category of queen rearing centers includes: the Abha, Rajal Alma, Al-Medina and Hail queen rearing centers. All of the centers were established a long time ago as beekeeping training and demonstration stations and now all are more or less in similar condition. Except for the Rjal Alma Center, all have shelters for the bees and have training rooms except in the Abha center. The centers under this category have no suitable rooms for grafting, storage and offices. In terms of manpower, where only low-level technicians attend to the bees; all the centers have no qualified/experienced technician capable of rearing queens. In order for these centers to operate optimally, the rearing and supply of queens will require well-experienced and qualified staff and additional suitable rooms for grafting, storage, and offices.

In addition to the existing centers the suitability of 3 newly proposed centers for the establishment of queen rearing station has been assessed based on availability of optimum bee forage, water for development of forages, sufficient land for establishment of forages, and expansion and the proximity of the centers for utility and service

centers. Accordingly, Namas (Aseer Region), Al-Edabi (Jazan Region) and (Al-Arj) from Makkah region have been recommended for the establishment of new queen rearing centers. Based on the general assessment and gaps observed the following general recommendations are provided.

1. **Focusing on few queen rearing centers:** Since the numbers of queen rearing centers are quite many, it is better to focus on strengthening and operationalizing only on a few of the queen rearing centers, then expanding to others based on the challenges and lessons learned. Moreover, some of the queen rearing centers are either very old, and built with limited capacity in the past have simply been upgraded into queen rearing centers. So, more physical facilities should be built and upgraded well to meet the minimum requirements of ideal queen rearing centers. All the necessary equipment and devices required for queen rearing such as grafting needles, standard nuclei hives, queen cup cells, different queen cages and others should be provided.
2. **Establishment of sufficient bee forage plants:** Along with the efforts in strengthening and establishing queen rearing centers, more emphasis should be given to the establishment of large scale areas as pollen source bee forage plants in and around the queen rearing centers.
3. **Focus more on operationalization of the queen rearing centers:** Along with strengthening of the queen rearing centers physical facilities, it is important to start queen rearing activities soon on some of the selected queen rearing centers with the existing facilities.
4. **Upgrading of some of the queen rearing centers into multipurpose honeybee centers:** In addition to queen rearing activities, it is better to upgrade some of the centers to serve as multipurpose bee centers involved in demonstration of improved beekeeping technologies and practices, provision of practical training on queen rearing and other improved management practices, and application of adaptive research to evaluate the suitability of some beekeeping technologies and practices to local bees and conditions.
5. **Development of human resources:** One of the major gaps observed in all established queen rearing centers is lack of qualified/experienced staff. So employing and retaining sufficient qualified and experienced staff are very essential.
6. **Producing and supplying high quality of queens:** The queens to be reared and distributed have to be high quality, derived from strong and good performing mother colonies, from well-fed larvae and the queen should mate well and be able to store sufficient semen. So, there should be some sort of queen quality controlling mechanism. If inferior quality queens are distributed to the beekeepers, the trust and interest of beekeepers will be highly affected, and it will be difficult to reverse it.
7. **Focusing on selection and breeding towards genetic improvement of the local honeybees:** One of the reasons for the preference by beekeepers for imported bees is associated with their high hoarding tendency and higher honey yield. So as a long-term plan it is important to select and breed the local bees towards their genetic improvement (increase their commercial values). Hence, some of the queen rearing centers involved in queen multiplication, should be assigned to focus on selection breeding for the genetic improvement of local bees. The selection programme should also consider the conservation of the indigenous honeybee race.
8. **Diversifying the supply sources of local honeybee queens and package bees.** It is suggested that in addition to the queen rearing centers, potential private queen breeder companies and large number of interested and experienced beekeepers should be involved in rearing and supplying queens and should be encouraged. However, registration of honeybee queen breeders and queen quality control mechanisms should be implemented to rear and supply best performing quality queens to beekeepers.

**Table 4.** Old and new queen rearing centers found in the country

#	Region	Location	Status	Beekeeper's association managing the center	Queen rearing status
1	Al-baha	Buljarshi	Established	Al-Baha	started
2	Asir	Abha	Established	Al-Baha	Colony established
3	Asir	Rajal Alma	Established	Nahal	Colony established
4	Asir	Namas	Under establishment		
5	Jazan	Abu Arish	Under establishment	Al-Baha and Nahal	Colony established
6	Jazan	Al-Edabi	Under establishment		
7	Mekha	Taif	Established	Al-Baha Beekeepers Association	Colony established
8	Riyadh	Riyadh *	Established	Nahal	Colony established
9	Medina	Established	Established		
10	Qassim	Unizah †	Established		

\* It is assigned as beekeeping development center

† It is out of the current project target regions

## **12. Selection, genetic improvement, and conservation of the local bee races**

Along with queen rearing and colony multiplication efforts of the country, selection and genetic improvement of local bee races are very important. The selection and genetic improvement programme should also target maintaining the adaptive traits of the indigenous race to its local environment. In setting the selection parameters, both the adaptive traits and commercial values (productivity) should be equally considered. Selection and genetic improvement programmes require long term efforts and investment in human resources, research, budget, and facilities. As such, there should be a mandated government body that focuses on selection and genetic improvement of the indigenous bees.

As recommended above, some of the established queen rearing centers can be upgraded and mandated to focus on honeybee selection and genetic improvement programmes. For this, competent human resources, attractive salaries, sufficient long-term financial support and facilities should be allocated. The selection program should be linked to the honeybee research program of universities to measure, analyse the selection process and evaluate the performance of the selected breeds at every generation and at multi-locations. Perhaps, collaboration with research institutes/universities outside the country already advanced in this should be investigated. Student exchanges, collaborative research, and co-supervised masters and doctoral theses in this field, in collaboration with other countries can be considered in long term planning.

Genetically improved queens will be distributed to all the queen rearing centers and potential bee breeders involved in multiplication of queens and further selection programmes. Moreover, it is important to have isolated areas with sufficient buffer zone distances for natural isolated mating of selected queens. Along with this, development of skilled staff in artificial insemination of honeybee queens is very important to control the selection and breeding lines.

Along with selection and genetic improvement efforts, it is equally important to have strategies to conserve the indigenous honeybee race from introgression of exotic genes and subsequent genetic dilution. Some of the possible strategies include gradual banning of importation of exotic bees, delineation of certain geographical regions for local bees only and restricting the entering and exiting of bee colonies from delineated zones. In relation to this, areas that will be designated for local bee conservation should be large enough and should have different ecologies that allow the movement of the bees within a designated territory. In this regard, at initial stages, allocation of Aseer and Jazan regions together for conservation of the local bees would be an appropriate because the ecological diversities of these two regions would allow beekeepers to migrate their colonies in different seasons within demarcated territories. During delineation sufficient buffer zones (about 10km) should be created to minimize any chance of hybridization.

As assessed from the recent situation analysis most of the beekeepers from Aseer and Jazan regions prefer to keep local bee colonies and they are strongly against the introduction of exotic bees to their regions. Moreover, areas with permanent (cave) apiaries for many years should be registered as hot spot areas for conservation of local bees and introduction of bees to these sites should be restricted. To encourage beekeepers to keep local bees, honey from local bees and such delineated areas can be labeled and promoted for better price incentives.

## **13. Legislation related to the beekeeping and honey production**

In the Kingdom of Saudi Arabia, the direct legislative control over the beekeeping industry is the one approved by the Cabinet “Decision No. 65 of 3/8/1431”. The legislation has 16 articles, and it deals with different aspects of the beekeeping sector of the country. Some of the major issues addressed in the legislation are the authorization of MEWA to undertake general supervision of the sector: granting of licenses to establish apiaries, to permit import and export of bees, feeding materials, treatments and manufacturing and selling of beekeeping tools. Moreover, the legislation mandates the MEWA to collaborate with the relevant authorities for registration of medicines for bee diseases, pests, nutrients; to arrange the introduction of bee colonies into parks and reserve



areas; to conserve the indigenous local bee race; to protect the bee forages and coordinate their utilization; and issuing of instructions for production, trading, processing packing and displaying of bee products. The legislation states the obligations of beekeepers to report honeybee diseases and pests that have the potential to threaten the bee colonies, and also to take necessary measures when there is an official announcement for spraying of chemicals. The legislation restricts the use of chemicals, pesticides and antibiotics to treat honeybee disease and pests and the legislation states the application of penalties for violation of the regulations.

Generally, the legislation has tried to address wider important areas of the beekeeping sector, but the implementation of the established regulations is not yet well effected on the ground. Moreover, based on the dynamics of the situation and emerging issues, more regulations and industry code best practices and amendment of the previous regulations to meet the current situations, are important.

#### **14. Beekeeping and honey production sector challenges**

According to the sector reviewing and situation analysis, it is noted that the beekeeping and honey production sector has several challenges. Some of the challenges are:

- Low adoption of improved beekeeping technologies and practices and associated low production and productivity of beekeeping;
- Limited government support in areas of extension and technical support to beekeepers;
- Limited bee forage resources, overcrowding and resource competition and limited attention in bee forage plantation and absence of integration of beekeeping with natural resource conservation and rehabilitation activities;
- Skill and knowledge gaps of beekeepers and lack of need-based focused trainings;
- Absence of applied and problem-oriented research for generation, testing and adoption of technologies suitable to local bees and ecological conditions;
- Limited number of qualified human resources (honeybee experts) in the area of beekeeping development, research, and teaching;
- Prevalence of different honeybee disease, pests and predators and uncoordinated use of agrochemicals;
- High dependency of the country on exotic bees and absence of functional queen rearing and supply centers;
- Absence of selection, genetic improvement and conservation programmes for local races and lack of institutes to handle the program;
- Absence of value addition and product diversification;
- Adulteration and mis-labeling of imported honey as local honey and absence of regular quality inspections;
- Weak financial capacity of smallholder beekeepers to adopt improved beekeeping technologies;
- Lack of access to market for small scale producers;
- Absence of up-to-date reliable data on number of beekeepers, total number of bee colonies, number of colonies in box and traditional hives and honey yield per colony by hive types and total honey production. Absence of such baseline data may contribute to poor development planning, strategies, and policies.

## 15. SWOT of the beekeeping and honey production sector in KSA

Based on the beekeeping and honey production sector review and situation analysis, the major strengths, weaknesses, threats and opportunities of the sector have been identified. In the planning and implementing of the project activities it is important to consider both internal (strength and weakness) and external factors (opportunities and challenges) outlined in the SWOT analysis. Accordingly, during the implementation of the project plan, it is important to capitalize on the strengths, overcome the weaknesses, utilize the existing opportunities, and minimize the threats through proper management of any possible risks.. The summary of SWOT analysis of the sector is shown below in Table 5.

**Table 5.** Beekeeping and honey production sector SWOT analysis

<b>Strength</b>	<b>Weakness</b>
a) Existence of an ecologically well adapted honeybee race	a) Lack of sufficient proven beekeeping technologies suitable to local bees and conditions
b) Presence of long-standing traditional beekeeping practices	b) Absence of problem-oriented and demand driven applied research
c) Availability of diverse floral resources at different seasons and ecologies	c) Lack of strong extension services and technical support
d) Availability of beekeeping input manufacturers and suppliers	d) Absence of organizational structures at different levels accommodating the beekeeping subsector
e) Suitable infrastructure and accessibility of bee forage resources across the country	e) Limited qualified staff at the regional level
f) Availability of very diverse mono-floral honey types	f) Scarcity of indigenous honeybee colonies
g) Presence of model beekeepers' cooperatives/associations for benchmarking	g) High dependency on importation of exotic bees
h) High purchasing power of a significant proportion of the society	h) Low productivity of beekeeping
	i) Absence of value addition and diversification
<b>Opportunities</b>	<b>Threats</b>
a) Strong government commitment to support the sector	a) Deforestation and natural resource degradation that led to scarcity of bee forage resources/landscapes
b) Presence of different government development strategies and initiatives focusing on the development of beekeeping	b) Shortage and high price of local honeybees
c) Availability of soft funds, subsidies, and incentives for beekeeping	c) Recurrent droughts and climate changes
d) Attractive honey prices	d) Honeybee diseases, pests and predators
e) High potential of the sector for value addition and product diversification	e) Uncoordinated agrochemical sprays
f) High potential of the sector for agribusiness development and job opportunities for youth and women	f) Spread of adulteration
	g) Mis-labeling of imported honey as locally produced honey
	h) High summer temperature and low humidity

## 16. Beekeeping and honey production sector major gaps and possible areas of intervention

Based on the beekeeping and honey production sector review and analysis of the situation, the major gaps of the sector have been identified across the value chain and possible interventions required have been suggested.

**Lack of beekeeping extension services:** As generally noticed from sector review and situation analysis there is a limitation in beekeeping extension services at regional and governorate levels. Beekeepers are in the need of technical support in the areas of improved beekeeping technology adoption, utilization and honeybee disease controls and others. Hence, the provision of technical support to beekeepers through assignment of beekeeping extension service staff at beekeeping potential regions and governorates, regular visits to beekeepers and their apiaries, and preparation and dissemination of beekeeping extension materials on different aspects of beekeeping (in both hard and soft copy, as well as in online audio and video) are very important to support beekeepers to improve their good beekeeping practices in a sustainable ways.

**Limited beekeeping training services:** During the situation analysis, many smallholder beekeepers indicated that their skill and knowledge gaps are the major problems to adopt improved beekeeping technologies and sustainable practices to improve the production and productivities of their bee colonies.

Training is important to build the skills and knowledge of beekeepers and to change their attitudes towards sustainable beekeeping practices, improved beekeeping technologies and to manage their colonies following their seasonal dynamics. So different levels of standardized training programs should be designed and implemented for different categories of beekeepers based on types of technologies adopted (traditional and modern), types of honeybee races used (indigenous and imported) types of practices (migratory and stationery) and holding sizes (small holders and commercial). The training should be designed for different categories of beekeepers based on their need assessments, focusing on more practical applications and on local bees and environmental conditions. Different training modules should be prepared, and training of trainers should be conducted (including staff working in extension services or veterinarians).

**Limited applied honeybee research:** Some universities like King Saud University and King Khalid Universities have been conducting some apicultural research and very useful results were published. However, the research programmes are centered on individuals' academic interests and did not target the existing problems of beekeepers. In this regard there is no mandated beekeeping research organization in the country.

Research is the backbone of any development activities. Since the honeybee races of the country are unique and the environmental conditions are also different, it is necessary to conduct research focusing on problems of local bees and conditions. In this regard it is necessary to have honeybee research mandated units at appropriate universities or at agricultural research centers. The units should have sufficient competent human resources and budget. In this regard the Jazan Agricultural Research Center might be an appropriate center to start honeybee research activities. Moreover, some of the queen rearing centers can start applied research activities to test and adopt some of beekeeping technologies and practices based on local bees and conditions.

Universities in the country should give more attention to problem-oriented and demand-driven applied apicultural research in the context of local conditions to support the development of the sector and to reach the communities around the universities. Moreover, at university level, starting apiculture related Masters or PhD programmes for exchange students with some appropriate universities abroad will be very important. Students could collect data and information in the KSA and do their PhD abroad and being experienced in the field. This would result in a long term development of capacity in area of beekeeping in the country.

**Low adoption of improved beekeeping technologies:** Beekeeping in the Kingdom of Saudi Arabia is still dominantly traditional, and the major proportion of the bee colonies are kept in traditional hives with its limited improved management options, low production and productivity. Besides lack of technical supports and skill and knowledge gaps; limited financial capacities of smallholders have been identified as one of the major factors for low adoption of improved and sustainable beekeeping technologies practices.

To increase the honey production and productivities and to harvest diversified bee products in the country, it is necessary to transform the existing traditional beekeeping practices into more modern but sustainable beekeeping practices. It is therefore necessary to avail all major inputs as packages; conduct pilot demonstrations of sustainable beekeeping practices and technologies, training, awareness raising on good beekeeping practices; and provide extension support and access to financial resources. Following pilot demonstration of good beekeeping practices and technologies, promotion and large-scale adoption of good practices should be implemented. Regarding financial sources, the current government subsidy can be used as tool to introduce improved beekeeping practices. Supply of box hives and accessories can be linked with the newly trained and organized youth groups to manufacture and supply hives and beekeeping inputs. Such interlinked approaches will be sustainable and effective to transform the beekeeping sector of the country as a whole.

**Absence of suitable modern (box) hives and accessories:** Many workshops in different parts of the country are producing box hives and frames and are available at reasonable prices. However, the types of hives and frames produced and used are the one designed based on prototypes of hives developed for European bees and conditions. The local bees are the smallest honeybee race with different bee space, natural nest architectures and brood cells dimensions.

So, modern hives and accessories should be designed and produced based on the biology, morphology and behavior of the local bees and environmental conditions. Once such a national prototype is approved it should be standardized to be produced in all workshops in the country.

**Absence of standards for hives and accessories:** Hives and frames produced from different workshops within the country differ and create problems of interchangeability. It is therefore important to have national standards for box hives, frames, beeswax foundation casting molds, queen excluders, pollen traps and other inputs. During standardization it is also important to consider the biology, morphology, and natural nest architectures of the local bees.

**Absence of bee products diversifications:** In the country only honey is produced, but in beekeeping there are several high value bee products (such as pollen, propolis, and royal jelly) that can be produced and marketed. Commercialization of high value bee products through pilot testing, demonstration and creating markets for those products, should be promoted.

**Shortage of honeybee colonies:** There is a big gap in honeybee colony demand and supply as result the country imports more than one million exotic packaged bees annually. In addition to being an unsustainable approach, the importation of exotic bees poses threat on genetic composition of the indigenous bees and contributes to introduction and dissemination of various honeybee disease and pests.

For the sustainability of the beekeeping industry, the country should focus on production and supply of local queens and packaged bees through strengthening the queen rearing centers. For the centers to become efficient, recruiting and retaining of qualified and experienced professionals on long-term bases are important. Besides the queen rearing centers, it is important to encourage other potential individual beekeepers and organized youth groups to rear and supply queens. The individual queen breeders can supply their queens to beekeepers in their respective areas and if they have more queens, they can supply to the beekeepers' cooperatives. The individual queen breeders and organized youth groups gradually would grow into large-scale queen breeders and suppliers as is done elsewhere in the world. So, such groups should be trained and technically supported. Individual level queen rearing practice is advantageous for obtaining sufficient drones for successful mating of virgin queens. Along queen rearing, production and supply of local packaged bees with 2-3 frames nuclei hives is important to address the local honeybee colonies shortage.

**Absence of selection and breeding programmes:** One of the important gaps of the sector is low productivity of local bee race and its one of the main reasons that some beekeepers prefer to use imported bees for their better productivity and high hoarding tendency.

To improve the productivity of the indigenous bees, it is necessary to have a long term selection and breeding programmes with well-established objectives and goals to improve, conserve, multiply and distribute the selected stock breed to the queen rearing centers and queen breeders. For this, a mandated unit or department should be established either under the MEWA or agricultural research center or university. The unit should have its own dedicated and qualified permanent staff with a regular annual operating budget.

**Absence of conservation strategy for indigenous bee race:** Mass importation of exotic bees and possibility of gene introgressions have been perceived as important gaps in the sustainability of the sector. Some of the possible conservation strategies include: areas with permanent (cave) apiaries with local bees for many years should be registered as hot spot areas and introduction of bees to these sites should be restricted. Moreover, delineation of certain geographical regions for local bees only and restricting the entering and exiting of bee colonies from delineated zone, should be practised. Because of low introduction of exotic bees into the Jazan and Aseer regions, the areas can be delineated for local bees only. Efforts should be made to encourage beekeepers to keep local bees and honey from local bees and delineated areas can be labeled and promoted to get better prices. Gradual banning of the importation of exotic bees is also suggested.

**Limited bee forage conditions:** Shortage of bee forages and serious competition for resources among bee colonies from different apiaries and subsequent declining of the productivities of colonies are major gaps in the sector.

Beekeeping is more dependent on the existing natural environmental conditions of an area than any other livestock production practice. To improve the production and productivities of beekeeping and to maintain its sustainability it is important to have extensive planting of bee forages and integration of beekeeping with natural resources management programmes. Moreover, integration of beekeeping with horticultural crops production (growing of tropical fruit trees, orchards, coffee and others) is very important to benefit from the pollination services of bees and to increase also honey production.

**Overstocking and resource competition of colonies:** Overcrowding and resource competitions among and within apiaries are some of the major problems of beekeeping in the country. In this regard, besides applying MEWA's colony and apiary tracking smart technology, overstocking of colonies can be regulated easily through regulating of optimum number of colonies per site and determining optimum distances between the two adjacent apiaries. Moreover, raising the awareness of beekeepers to keep fewer but more productive colonies rather than focusing large numbers of unproductive colonies and keeping colony numbers based on the optimum carrying capacity, which would be very important to minimize overstocking of colonies.

**Absence of honeybee diseases and pests control measures:** Infestation and dissemination of various honeybee diseases and pests and lack of regular surveillance and quarantines are important gaps of the sector. Generally, to minimize the infestation and dissemination of honeybee diseases within an apiary, it is better for beekeepers to apply prevention, IPM and biomechanical treatment measures rather than focusing on chemical treatments which is important to avoid the contamination of honey with chemical residues. The establishment of strong border quarantine systems to halt the introduction of various honeybee diseases and pests together with live bees and used equipment importation, and making regular surveillance on diseases occurrences will be useful to control the introduction and dissemination of honeybee diseases and pests in the country. Moreover, veterinarians, extension services and boarder quarantine staff should get adequate training on diagnosis, identification and treatment of honeybee diseases and pests.

**Limited rules and regulations and lack implementation:** The country has some basic rules and regulations regarding the safety of bees and use of chemicals, pesticides and antibiotics. However, absence of implementation of the established rules and regulations, and amending them to meet the current situations, are important.

**Lack of national honey quality testing procedures and protocols:** Inconsistencies in honey laboratory tests results have been reported. So, it is important that the Saudi Food and Drug Authority has up-to-date national honey quality testing standards, procedures and protocols that comply with international standards (Codex). Besides the physicochemical quality parameters, there should be a test for checking acceptable residue levels of agrochemicals, antibiotics and any environmental contaminants for both locally produced and imported honeys following the Hazard Analysis Critical Control Point standards. Moreover, compliance of the physicochemical quality test parameters with melissopalynological analysis would be very important to detect the geographical and botanical origins of honey and to protect the locally produced honeys from mislabelling and blending with imported honeys.

**Partnership opportunities:** In the area of beekeeping and honey production there are no well-established partnerships for KSA. In the sector there are several partnership opportunities to establish and to learn from their success stories and best practices. Some of the potential partnerships include: Apimondia, Romanian Institute of Research and Development for Apiculture, King Khalid University (Abha) and Albaha Beekeeper's Cooperatives and others. The possible area of partnership opportunities are given in section 9.2.

**Focus on employment for youth and women in the sector:** The involvement of youth and women in the beekeeping sector is very low in the KSA. As outlined in section 10 of this document there are several beekeeping related untapped agribusiness opportunities across the value chain starting from production of primary bee products, by-products value addition, and product diversification, through to marketing and service delivery that can serve as self-employment opportunities for youth and women. So, it is important to focus on engaging youth and women through adequate skill and knowledge training, financial and technical support, establishing business incubation centers and creating market linkages to their products. In this regard identification and engaging of all relevant stakeholders along the whole value chain of the beekeeping and honey production sector, are very important.

## **Conclusion**

In order to enhance the development of the sector, it is important to strengthen institutional support in areas of extension, research and training. Moreover, transforming of the existing traditional practices into a modern and sustainable beekeeping sector through pilot testing, demonstration of good beekeeping practices and improved technologies, value addition, product diversification, scaling up the adoption of technologies together with access to financial sources targeting youth and , are very important and have to be accompanied by thorough cost-benefit analyses. In addition, focusing on strengthening of the capacities of production and supplying of local queens, developing and implementing policies and strategies for selection, breeding and conservation of local race are very essential. Moreover, emphasizing the improvement of the bee forage landscapes of the country through largescale planting of forages and integration of beekeeping with natural resource management programmes and agroforestry practices are very essential. Finally, minimizing the infestation and dissemination of honeybee diseases and pests through prevention, IPM and biomechanical measures and finally having comprehensive and up-to-date rules, regulations, standards, procedures and protocols that contribute to enhance the development of the sector, are very important.



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