Food and Agriculture Organization of the United Nations

Reef ريف

وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture

Assessment of honeybee disease (nosema) in the Kingdom of Saudi Arabia BEE/051/2022/6

Strengthening MoEWA's Capacity to implement its Sustainable Rural Agricultural Development Programme (2019-2025) (UTF/SAU/051/SAU)

Food and Agriculture Organization of the United Nations

Riyadh, Kingdom of Saudi Arabia

Contents **Pages**

1 Introduction

1.1 Current beekeeping practices in Saudi Arabia

Beekeeping is a longstanding and widely practiced agricultural activity that run in most rural areas of the Kingdom of Saudi Arabia, and it serves as additional source and diversification of incomes for around 13 000 rural households. Significantly more citizens are also engaged across the beekeeping value chain (processing, manufacturing, input supplying and marketing). In the country, beekeeping is practiced using around 1 million well adapted indigenous bee race (*Apis mellifera jemenitica*) and over 1 million annually imported exotic package bees. Beekeeping is still dominantly traditional in which around 50 percent of the bee colonies are kept in local hives. The trend of transforming into modern hives is steadily increasing and there is a healthy demand for honey. The total annual honey production is about 4700 tonnes, however,the productivity of colonies is relatively low, 3.7 kg and 7.5 kg honey/colony per annum in local and box hives respectively which is far below the world average honey production (20 kg/hive/annum).

Despite the arid climatic conditions, the Kingdom produces more than 13 different mono-floral honeys and the average price of locally produced honey is very attractive and contributes to attract and sustain many citizens to involve in the beekeeping business. About 74 percent of the beekeepers hold between 100 to 1000 colonies which is economy of scale the country imports more than 20 000 tonnes of honey annually to fill the gap in demand.

Generally beekeeping sector has several comparative advantages to the Kingdom of Saudi Arabia (KSA): it is environmentally friendly activities that can be integrated with the conservation and rehabilitation of natural resources and can be run without competing for arable land and water which are scarce resources in the country. Moreover, the development of the beekeeping sector fits well to the Saudi Vision 2030 Strategic Objective “Protect and rehabilitate natural landscape” and “Contribute to rural development and provide adequate living conditions for small agricultural producers”. Moreover, the sector has great potentials in agribusiness to create jobs for rural youth and women. Currently the government of Saudi Arabia has several development initiatives to advance the beekeeping sector.

1.2 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. 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 may migrate their colonies for more than 1 000 km. The frequency of migration may vary from 2-9 times per annum with mean of 3 times/annum. Migratory beekeeping practice, besides its contribution in allowing resource

utilization that found in different seasons and ecologies, it contributes for rapid spread of honeybee diseases and pests.

1.3 Maintaining 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. Beekeeper may keep up to 500-600 bee colonies in one site. Moreover, there is no agreed distances between two adjacent apiary sites. Overstocking of colonies and lack of optimum distances between adjacent apiaries significantly contributes for rapid spread of honeybee diseases and pests among colonies and apiaries.

1.4 Honeybee races of Saudi Arabia

Beekeeping in the Kingdom is practiced 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. The indigenous bee race is well known for its best adaptation to the semi-arid and desert conditions of the country. The race is reported to cope up well with long dry periods, brief flowering intervals, temperatures of up to 40 °C, and annual rainfall of just 50 to 100 ml. One of the adaptation mechanisms of the race in such semi-arid climatic condition is by limiting its brood and adult bee population size during long dearth period not to put its colony at high risk under erratic rainfall and unpredictable weather conditions of the region. Such behavior is a good surviving strategy for the bees to escape the harsh period. Behaviorally, the race is relatively gentle and calm without much tendency to sting even after provocation. 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. Because of its long years of natural selection, the local race is best adapted to local environmental conditions. So, emphasis should be given to improve the productivity (commercial values of the local bees) through, selection breeding while targeting to conserve and sustainable use of the indigenous bees rather than depending much on the importation of exotic races.

1.5 Imported hybrid bees

The country imports more than one million package bees annually.. The imported bees are preferred by some beekeepers because of their fast establishment in box hives, comb construction, high hording tendency, fast in collecting and storing nectar and even sugar syrup. The most 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 package bees die soon after the first honey harvest and the remaining also gradually vanish in less than one year period. The possible factors for death of the imported colonies could be due to lack of adaptation to the new environment. It could be also lack interest by beekeepers

to manage the imported bees after honey harvest. Mass importation of exotic bees poses high risk on local bees in introduction and spread of various honeybee diseases and pests into the country. The imported bees may also contribute for genetic dilution of the local bee race through the introgression of exotic genes. Beekeepers complain on imported bees for their aggressive robbing behaviour.

2. Honeybee health and diseases, pests and predators in KSA

Different honeybee diseases, pests and predators are reported to exist in most parts of the Kingdom. According to Al-Ghamdi (2010), Nosema, Amoeba, Chalkbrood, Varroa destructor, European Foul Brood, and different bee paralysis were reported to exist in the country. The occurrence of Nosema and European Foul Brood were further confirmed by Ansari *et al.,* (2017ab). American Foul Brood reported to occur only on one apiary site in Taif (Ansari, *et al.,* 2017c). Besides honeybee diseases, many species of honeybee pests and predators (wasps, hornets, wax moths, ants, beetles, reptiles and different bee-eater birds are reported to attack honeybees in the country (Al-Ghamdi (2010).

In late 2021 and early 2022, many beekeepers from different regions of the country have complained for the death of their bee colonies starting from the month of October, 2021 to the end of March, 2022. According to the beekeeper's report, the bee colonies death rate and the area coverage were exceptionally high than before. In response to this problem; FAO-KSA established a technical team composed of two international honeybee disease experts and two FAO-KSA staff (TA and NPO) to make assessments on the honeybee diseases situations and its impacts in selected target regions of the country where frequent honeybee death reports were coming from.

3. Honeybee health and diseases control enabling environments

3.1 Legislation, related to honeybee health and disease in the KSA

In Kingdom of Saudi Arabia, "The Agriculture law" promulgated by Royal Decree No. (M/64) of 10/8/1442 A.H. The Regulations were adopted by the Minister of Environment, Water and Agriculture Decree No. 14967/1/1444 and 15/1/1444 A.H. Some of the major issues addressed in the legislation are the authorization of MEWA to undertake general supervisions 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 mandated the MEWA with the collaboration of the relevant authorities for registration of medicines for bee diseases, pests, nutrients; to conserve the indigenous local bee race. The legislation states the obligations of beekeepers to report honeybee diseases and pests that has a potential to threat the bee colonies and also to take necessary measures when there is official announcement for spray of chemicals. The legislation restricts to use chemicals, pesticides, and antibiotics to treat honeybee disease and pests and the legislations states the applying 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 materialized at the ground. Moreover, based on the dynamics of the situation and emerging issues, more regulations and industry code best practices and amending of the previous regulations to meet the current situations are important.

3.2 Honeybee health and diseases control related capacities

Currently the MEWA has established honeybee disease diagnosis and testing laboratory in Riyadh at Wadi Namar. The laboratory is equiped with the necessay facilities and it will start operating soon as private public partnership. Moreover, MEWA has established 4 honeybee mobile clinics and 3 mobile quarantine facilities. All these services planned to be run by private sector with support of government and expected to improve the honeybee disease extenstion services of the country. However, currently MEWA lacks honeybee diseases specialists to play regulator roles and to coordinate and monitor the implementation of planned projects and also to give honeybee disease related advisory services. In addition in the country, dispite the recurrent of honeybee diseases; there is no regual honeybee disease survilances, detection, early warning, and control practices.

4. Approaches followed to assess the honeybee diseases prevalence in the target regions of KSA

Between October, 2021 to the end of March, 2022, the beekeepers reported to MoEWA that colonies death rate and the area coverage were exceptionally high. In response to this problem, the FAO-KSA under the Beekeeping and Honey Production component of the ongoing Sustainable Rural Agricultural Development Project (SRAD) established an international technical team to address the issue in collaboration with MoEWA. Two international honeybee disease experts joined SRAD's BEE team comprising the TA and NPO to undertake assessments of the honeybee disease situation and its impacts and prepare a long term national strategy in that area. The TORs of the experts are provided in Annex.

The assessment was focused on identification of important major honeybee diseases those are recorded by OIEas economically relevant diseases such as: Varroosis, Nosemosis, Virosis, American foulbrood, European foulbrood, and others.

The major objective of this work was to investigate the occurrences of the above-mentioned major honeybee diseases in the KSA. Moreover, it was aimed to identify major gaps in beekeeping practices responsible for rapid spread of honeybee diseases and pests in the country. Based on these objectives, the team conduct field missions to five major affected regions including Madinah, Makkah, Jazan, Al-Baha and Riyadh. Imported samples of bees were also collected from quarantine section of King Khaled International Airport, Riyadh. Further two honeybee samples suspected with diseases were received from Al-Jouf Region for diagnostic tests. The main approaches used for diagnosis the bee samples disease is discussed below.

For the identification of pathogens, besides professional observations for associated disease symptoms and clinical signs, random honeybee samples were collected or/and diagnosed on spot following the standard procedures for different honeybee diseases. In addition, the rate of mortality of honeybee colonies were estimated based on beekeepers reports on the number of colonies died between October 2021 to March 2022. Finally, samples were sent to Istituto Zooprofilattico Sperimentale del Lazio e Toscana (**IZSLT**), Rome, Italy, (https://www.izslt.it/eng/) which also acts as FAO reference center for disease detection and analysis.

5. Major findings

5.1 Nosema disease

Concerning on detection of Nosema disease, 161 adult honeybee samples from 161 colonies both from local and imported package bee colonies were collected following the standard procedures for sampling and preserved in 70 percent alcohol (Fig. 1). Besides sample collection, clinical signs for the presence of diarrhea which mostly associated with *Nosema apis* were observed and recorded (Fig. 2). Moreover, neurological signs in adult bees that go pedal staying steady in dorsal or in lateral position, with bloated abdomen were observed which is the typical sign of Nosemosis. In addition to *Nosema apis*, these signs may allow to suspect to particular aggressive strains of *Nosema ceranae* and/or to the *Chronic Bee Paralysis Virus* (CBPV), as well as *Malpighamoeba mellificae* which require further detail investigations.

The samples were sent to IZSLT specialized veterinary Laboratory in Italy for DNA (PCR) tests. During laboratory analysis, the samples were pooled according to their: region, apiary, origin (local or imported) and presence of signs of diseases. The presence or absence of the Nosema spores and their rate of infestation was determined following microscopic analysis adopting standard procedures. Once the samples were confirmed for the presence of Nosema spores, DNA (PCR) tests was conducted to differentiate the types of Nosema species responsible for Nosemosis in the KSA following the standard procedures. The PCR test result showed that out of the 40 pooled local honeybees' samples collected (from Al-Baha, Jazan, Madinah, Makkah and Al-Joaf) and tested for Nosema disease 45 and 55 percent of them were found to be positive for *N. Ap*is and *N. ceranae* respectively (Table 1). However, the rate of infestation was varying from 0-100 percent among regions and apiaries (Table 1). According to the sample analysis relatively higher rate of Nosema infestation were recorded for Al-Baha, Jazan, Madinah samples. The two honeybee samples from Jouf found to be negative for both species of Nosema. The co-occurrences of the two Nosema species within apiaries and regions (Table 1) could be one of the reasons for the significant depopulation and subsequent death of colonies in these regions in last seasons.

It was further noted that specific strain of *Nosema ceranae* was detected in 6 samples collected from Madinah, Makkah, Jazan, Al Baha regions. According to the IZSLT Laboratory PCR test result this specific strain was represented by *Nosema ceranae* isolate (Accession number ON596641 with 1 - 100% sequence identity, 100% query cover). The isolate DNA sequence was reported to be originated from Egypt and submitted to GenBank in May 2022 by the Pest Physiology Research Department and Apicultural Research Department of Plant protection Research Institute, Nadi. The imported bees are found positive only for *Nosema ceranae* with 56.3 (40 -100) percent of infestation (Table 1). The absence of *Nosema apis* from the imported bees may indicate that *Nosema apis* has been endemic to KSA.

Table 1. **Summary of honeybee diseases** test results of the 31 honeybee apiaries samples collected from 5 infested regions of KSA

Local bee samples									
Region bees	**No. Apiaries inspected**	**No. of pooled Samples analyzed**	**Varroa Infestation rate (no./apiaries/ hives sampled)**	**Varroa spp**	***Nosema apis***	***Nosema ceranae***	***Acarapis woodi***	*Lotmaria passim*	*Crithidia mellificae*
Al Baha	5	5	(5/7) = 71.4%	(1) 20%	(5/5) 100%	(5/5) 100%	0%	(0/5) 0.0%	(3/5) 60.0%
Jazan	8	9	(8/18) = 44.4%	(2) 25%	(5/9) 55.6%	(6/9) 66.7%	0%	(2/9) 22.2%	(1/9) 11.1%
Madinah	7	9	(7/22) = 31.8%	(3) 42,9%	(5/9) 55.6%	(6/9)66.7%	0%	(2/9) 22.2%	(0/9) 0%
Makkah	9	15	(9/23) = 39.1%	(2) 22,2%	(3/15) 20.0%	(5/15)33.3%	0%	(3/15) 20.0%	(0/15) 0%
Al-Jouf	2	2	(0/2) = 0.0%	NA	0.0%	(0/2) 0.0%	0%	(0/9) 0.0%	(2/2) 100%
Total	31	40	**44.3%**	**20.0%**	**45.0%**	**55.0%**	**0.0%**	**17.5%**	**15.0%**
No of samples positive over no. tested			**(31/70)**	**(8/40)**	**(18/40)**	**(22/40)**	**(0/40)**	**(7/40)**	**(6/40)**
Imported bees									
Al Baha	1	1	NA	0%	0%	100%	0%	100%	0%
Riyadh	5	10	(5/10) = 50%	0%	0%	60%	0%	50%	10%
Airport - quarantine	2	5	(2/2) = 100%	0%	0%	40%	0%	20%	0%
Total	**8**	**16**	**58.3%**	**0%**	**0.0%**	**56.3%**	**0.0%**	**50.0%**	**6.3%**
No of samples positive over no. tested			**(7/12)**	**(0/16)**	**(0/16)**	**(9/16)**	**(0/16)**	**(8/16)**	**(1/16)**

NA = data not available

5.2 Varroosis

Varroosis is one of economically important honeybee diseases which is caused by mite called *Varroa destructor* and it is widely found in the country. During field mission detection and quantitative analysis of varroa mites were done based on standard procedures: dislodging and counting of the adult varroa mites using powder sugar. For each sample about 300 adult bees were collected in plastic jar and mixed with fine powder sugar and shacked to evenly mix the powder sugar with bees then left bees to settle for 3 minutes. Then the number of mites counted and expressed following FAO, (2020) procedures for diagnosis of the Varroa mites. Out of the 70 pooled local honeybee colonies samples (from Al-Baha, Jazan, Makkah and Madinah) diagnosed for Varroa tests, about 20 percent of them found positive with range of 20 - 42 percent mite infestations (Table 1), which is relatively higher infestation rate compared to benchmarking rate of varroa mite not to exceed 2 percent in spring under European conditions. The honeybee samples collected from Jouf and imported bees from were free from Varroa spp.

Fig. 1 - The 161 adult honeybee samples collected and sent to IZSLT Italian laboratory

Fig. 2. Clinical signs of diarrhea on hives associated with *Nosema apis*.

5.3 American and European Foul broods

Even through the American and European foul broods were previously reported to exist in the country, in the current survey, the team could not find clear clinical signs for the presence of the diseases infesting

the local colonies. However, four suspected brood samples were collected and sent to IZSLT Laboratory in Italy together with adult bee disease samples and the result will be reported as it is received.

5.4 Other parasite honeybee diseases

Other honeybee diseases Trypanosomatids parasite, *Lotmaria passim* and *Crithidia mellificae* were also detected to occur in 17.5 and 15 percent (respectively) of the 40 pooled samples from four regions (Table 1). The diseases are well known honeybee intestinal parasite and share hosts with *Nosema ceranae* and are very prevalent in honeybee colonies and reported for potentially contribute to colony losses that currently represent a serious threat to honeybees (Gómez-Mora, *et al.*, 2020).

Myasis *(Apocephalus borealis)*

During field mission the team also observed some parasitoids: like the honeybee Myasis (Fig. 3 and 4) which may play a role in affecting honeybee health, especially in some time of the year like in the months of Spring and Autumn. This requires further, follow-up and investigation to confirm and assess the degree of prevalence and impact of Myasis disease in the KSA.

Further investigations on the presence of different honeybee virial and bacterial diseases are still under investigation.

Fig. 3. Myasis of honeybees isolated in the Jezan region (*Apocephalus borealis*, to be confirmed)

Fig. 4. Another fly, parasitoids on KSA honeybees, isolated in Riyadh region – to be identified.

5.5 Total honeybee mortality rates

Based on the 39 interviewed beekeeper's response from the infested areas of Makkah, Madinah and Jazan regions, the total death rate of colonies was 41.7 percent. Since the survey was made on few and specifically highly infested areas, the result does not represent the whole country and uncovered regions.

Such death rate of colonies is relatively higher than annual death rate of bee colonies recorded in most of EU countries which ranges from 10-30 percent. The possible cause of the death is associated with Nosemosis, which is aggravated with the occurrences of stresses that happened as result of shortage of pollen source bee forages which was because of rain shortage at the end of 2021 in lowland areas of the country.

6. Gaps observed in honeybee management related to health and disease control:

6.1 Limited use of good beekeeping practices:

According to FAO (2020), the good beekeeping practices (GBPs) are defined as "those integrative activities that beekeepers apply to beekeeping production to achieve optimal health for people, honeybees and the environment". Implementing GBPs has a positive impact on honeybee colony health and society, while also being able to ensure high production standards. However, under local conditions good beekeeping practices following one health approach caring for people, honeybees and environment are lacking. Integrated practice that focuses on prevention measures than treating the affected bees are lacking.

6.2 Inadequate/limited use of modern hives:

Significant proportion of beekeepers in the KSA prefer to keep bees still in local style hives (Fig. 5). However, the use of such hives strongly limits the application of good beekeeping practices to prevent and control honeybee diseases and pests: inspection of hives, early detection of symptoms of diseases and proper application of prevention and control measures.

Fig. 5. Local style hives, limiting access for proper inspection and early detection of infection

6.3 Overcrowding of colonies:

Beekeepers in Saudi Arabia tend to keep large number of colonies per unit area. It is very common to find up to 500-600 colonies in one apiary (Fig. 6). The world recommended number of colonies per 2.5 km^2 or at radius of 530 meter is nearly 100 bee colonies. Not only beekeepers keep more bees per site, but they stack large number of colonies one over the other (Fig. 6). Keeping large number of colonies in one site,

beside leading to resource competition, and declining of productivity, it contributes for rapid spread of honeybee diseases through drifting, common feeding and overlap of foraging areas. Moreover, there is no optimum distance to be maintained between adjacent apiaries. Sometimes beekeepers keep their bee colonies together with someone's apiary for guarding purpose without considering the congestion of colonies and disease transmission risks and resource competitions.

Fig. 6. Overstocking colonies beyond carrying capacity that exposes to the spread of diseases and resource competition malnutrition

6.4 Communal feeding of colonies:

Beekeepers in the KSA feed and provide water to their colonies mostly in common containers, or other utensils outside the hive. During external feeding colonies from adjacent apiaries also may come to feed in the same trough (Fig. 7). Because of the direct contacts and contamination of the feed and water with their faeces it may lead for rapid spread of honeybee diseases.

Fig. 7. Container for collectively feeding and watering of bees which is responsible of rapid transmission of honeybee diseases, especially Nosemosis.

6.5 Discarding of contaminated combs and used frames around apiary:

Many beekeepers in KSA do not care about how to recycle old combs and used frames and simply they discard around apiaries (Fig. 8). Such combs and frames can be from colonies that might have died or absconded because of some diseases and pests. When such combs are discarded near to apiaries, forager bees may come to forage on remnants of honey, propolis and also beeswax and they easily become infested and transmit the diseases to healthy colonies. Some pests like wax moth reproduce on discarded wax and start to reinfest bee colonies in apiaries,

Fig. 8. Discarded old combs and used frames around apiary and may contaminate healthy bee colonies

6.6 Lack of Biosecurity Measures to prevent and control of honeybee diseases

According to FAO, (2020) the term Biosecurity Measures in Beekeeping (BMBs) mean: "all those operational activities implemented by the beekeeper to reduce the risk of introduction and spread of specific honeybee disease agents". BMBs, are strongly associated with the genetic of the honeybees, the types of beehives used, the geographical area in which the bees are kept. Moreover, BMBs refer to each specific disease (e.g., BMs for varroa, BMs for AFB, etc.). BMBs are indeed related with local factors (e.g., climatic conditions, beekeeping technology, bee breeds or races), stressors (e.g., nutritional, pesticides, predators, etc.) or different prevalence, and/or economic impact of honeybee diseases. In KSA the BMB to prevent and control the honeybee diseases (banning of importation of live bees, and contaminated feeds and restriction of movement of bee colonies) are limited or a total absent. The prevention measures (good practices and early diagnostic measures) are not practiced.

6.7 Use of unregistered and banned medicines and antibiotics

Wide use of unregistered medicines and some banned antibiotics (Fumidil) as desperate attempt of beekeepers trying to control bee diseases are very common in the country (Fig. 9). Lack of awareness on the impact of the medicines used at the apiary level, as well as on the safety of the bee products (honey)

as result of residue and its impact on human health and on the possibility of developing antimicrobial resistance strains are very common threats.

Fig. 9. Some antibiotics and medicines which are banned in EU and US or used without being registered locally

6.8 Misuse of Phytotherapeutic products

Wide range of phytotherapeutic products are widely imported and used by beekeepers. The products sold at any marketplaces without having proper labeling of the active ingredients and instructions on how to use it. Moreover, local medicinal herbs were observed to be used by many beekeepers to treat some honeybee disease, however, the products are neither registered nor available scientific data that able to define dosage, time of administration, their efficacy and maximum residue limits (MRL) in the hive products.

6.9 limited welfare in handling of imported bees

It was observed that significant proportion of imported package bees are dying because of suffocation, stresses and shortage of feed and water (Fig. 10). The discarded dead bees may transmit honeybee diseases. Moreover, during honey harvest, beekeepers remove all the honey and abandon the imported bees without any feed that led aggressive robbing to the local bees and contribute for spread of honeybee diseases.

Fig. 10. High mortality of the imported honeybees at the arrival in the apiary and after the bees are transferred in new beehives

6.10 limited institutional supports

Shortage of qualified honeybee disease technicians, absence of honeybee veterinary services, lack of operational quarantine to monitor the introduction of honeybee diseases, the introduction of veterinary services and absence of strong extension services on honeybee are some of the limitations of institutional supports to control honeybee diseases in the KSA.

7. Potential factors contributing for the large-scale occurrences of honeybee diseases in KSA

Besides lack of proper management practices mentioned above, the prevalence of honeybee diseases and pests in the country could be due to mass importation of large numbers of package bee colonies annually without having proper quarantine system to check whether the imported bees are free from disease and pests. The other possible reason could be due to the extensive migratory beekeeping practices in which 95 percent of the beekeepers in the country migrate their colonies from place to place that lead to rapid spread of honeybee diseases. Overstocking of too many colonies within apiary and absence of optimum distances among adjacent apiaries may have also contributed for rapid dissemination of various honeybee diseases and pests in the country. Above all, lack of proper honeybee management that focus on prevention measures are also contributing for the prevalence of honeybee diseases in the country.

8. Recommendations to maintain honeybee health and diseases control

Some general recommendations those have to be implemented at beekeepers' level to prevent and control honeybee diseases and pests:

8.1 Recommendations at beekeeper's level:

8.1.1 Implementing Biosecurity Measures in Beekeeping (BMB)

Some of the BMBs for prevention and control of Nosema diseases are:

- **Queen renewal:** a very effective method to control of *N. ceranae* is replacement of queens with better disease resistance and performances. Young queens have a greater egg laying potential, and they produce a higher proportion of uninfected newly hatched bees to compensate for adult bee losses.
- **Genetic selection**: It is wise to select and rear queens with better tolerance to Nosema infections.
- **Phytotherapeutics:** There are plant extracts registered as trade products and able to inhibit Nosema spp. Some of plant products are: Thymol, Nozevit, Nosestat and Vitafeed Gold.
- **Essential oils:** There are essential oil extracts such as, *Laurus nobilis*, *Origanum vulgare* and *Rosmarinus officinalis, Cryptocarya alba* seem to be effective in controlling *N. ceranae* development in vitro.
- **Bacteria metabolite:** Surfactin is also reported to be effective in control of Nosemosis.
- **Organic acids:** Such as, lactic acid, phenyl-lactic acid and acetic acid are reported to be used for control *N. ceranae*.

8.1.2 General recommendation to beekeepers and their cooperatives

Implement good and integrative beekeeping practices focusing on improved management practices following one health approach.

- Use of modern hives to allow for early detection of honeybee diseases and applying of management practices (inspection) to prevent and control honeybee diseases.
- Avoid overcrowding of colonies that lead for rapid dissemination of honeybee diseases and pests.
- Keep optimum distances among adjacent apiaries,
- Avoid communal feeding and watering of bee colonies,
- Avoid use of unknown source bee products (honey and pollen) to feed colonies,
- Sterilize contaminated tools, hives, frames and others before using them for other bee colonies,
- Isolate any disease suspected colonies form healthy colonies,
- Do not discard or leave open any honeycombs, beeswax, and frames around apiaries,
- Collect and melt and reuse any old combs,

- Focus on biomechanical treatment measures than using chemotherapy,
- Avoid use of unregistered and banned medicines and antibiotics,
- Focus on prevention measures through building the immunity of bee colonies by proper feeding than focusing on treatment measures,
- Minimize the incidence of robbing and drifting of colonies through proper placement and management.

Recommendation for Beekeepers' cooperatives:

- Lead and play important roles in creation of awareness, and dissemination of information,
- Initiate honeybees pests and disease surveillance and early warning,
- Help implement compartmentalization measures,
- Assist with control of unregistered medicines and antibiotics,
- Strengthen beekeepers - government interaction,
- Support the formulation and implementation of appropriate honeybee health and diseases control strategy.
- To assist with apiary management, and early detection of pests and diseases, promote the use of modern bee hives.

Recommendations to beekeepers, prevent the outbreak of Nosema disease:

- It is well noted that, besides several contributing factors for the occurrence of Nosema disease, stress of bee colonies (in Autumn and Winter seasons) as result of shortage of both protein and carbohydrate source feeds are the major one. So, to prevent the occurrences of the disease, provision of sufficient protein and carbohydrate source feeds and migrating of bee colonies to natural pollen source areas are very important.
- To limit the spread of all honeybee disease (specially Nosema) when it occurs, it is important to implement compartmentalization plan.
- Ensure implementation of biosecurity measures at all times,

8.3 Recommendations to implemented at MEWA level

MoEWA has a great responsibility in keeping under control the risks for honeybee health and disease transmission through strengthening its regulatory capacity at different levels. Some of the areas that need attention are:

- Develop and implement appropriate honeybee health and disease control strategy.

- Play regulatory roles in use of veterinary medicinal products, imports of honeybees, feeds and used bee equipment and implementation of beekeeping national registration,
- Lead the preparation and enforcement of Biosecurity Measures in Beekeeping (BMB).
- Establish and operationalize surveillance, detection, and early warning system, and rapid response systems; set-upping honeybee disease contingency plans for some anticipated honeybee diseases and early notification for the possible occurrences and spread of honeybee diseases,
- Strengthen the veterinary laboratory diagnostic capacity; veterinary extension services; veterinary quarantine, border control and compartmentalization of disease suspected colonies
- Raise the awareness of beekeepers through training and exchange of knowledge and experiences,
- Implement residue monitoring plan through analysis of the residue of antimicrobial medicines and agrochemicals in honey, beeswax and other bee products for both locally produced and imported honeys.
- To help with apiary management, and early detection of pests and diseases, promote the use of modern bee hives.
- Implement early warning system to beekeepers for the spray of chemicals through coordinating among concerned authorities and private plant growers so that beekeepers move their colonies to safe places.
- Build competent human resources through employing competent and qualified honeybee disease technicians and experts to undertake survey and veterinary services.
- Improve the skill and knowledge of technicians through organizing consecutive trainings.
- Establish and operationalize queen and honeybee rearing centers to ensure local production of queens and package bees.
- Promote and assist local production of beekeeping inputs including supplementary feed.

9. References

Al-Ghamdi, A A (2010) Comprehensive study for current beekeeping industry of imported and native honeybee in Kingdom of Saudi Arabia. (Unpublished report).

Ansari, M. Javed, Ahmad Al-Ghamdi, Adgaba Nuru, Ashraf Mohamed Ahmed, Tahany H. Ayaad, Khalid Ali Khan and Noori Al-Waili (2017a). Diagnosis and molecular detection of Paenibacillus larvae, the causative agent of American foulbrood in honeybees in Saudi Arabia. International Journal of Tropical Insect Science, doi:10.1017/S1742758417000133

Ansari, M. Javed,, Ahmad Al-Ghamdi, Adgaba Nuru, Ashraf Mohamed Ahmed, Tahany H. Ayaad, Abdulaziz Al-Qarni, Yehya Alattal , Noori Al-Waili (2017b). Survey and molecular detection of Melissococcus plutonius, the causative agent of European Foulbrood in honeybees in Saudi Arabia. Saudi Journal of Biological Sciences Volume 24, Issue 6, PP 1327-1335, https://doi.org/10.1016/j.sjbs.2016.10.012

Ansari, M. Javed, Ahmad Al-Ghamdi, Nuru Adgaba, Khalid Ali Khan, Yehya Alattal (2017c). Geographical distribution and molecular detection of Nosema ceranae from indigenous honeybees of Saudi Arabia. Saudi Journal of Biological Sciences, Saudi Journal of Biological Sciences 24 (2017) 983–991, http://dx.doi.org/10.1016/j.sjbs.2017.01.054

FAO (2020). Good beekeeping practices: Practical manual on how to identify and control the main diseases of the honeybee (*Apis mellifera*). TECA – Technologies and practices for small agricultural producers, 1. Rome. https://doi.org/10.4060/ca9182en

Tamara Gómez-Moracho, María Buendía-Abad, MaríaBenito, PilarGarcía-Palencia, LauraBarrios, CarolinaBartolomé, XulioMaside, AránzazuMeana, María Dolores Jiménez-Antón, Ana IsabelOlías-Molero, José MaríaAlunda, RaquelMartín-Hernández, MarianoHiges (2020). Experimental evidence of harmful effects of *Crithidia mellificae* and *Lotmaria passim* on honeybees. International Journal for Parasitology, Vol. 50, No. 13, pp 1117-1124, https://doi.org/10.1016/j.ijpara.2020.06.009

Annex 1-TORs of International Consultants for Assessment of Bee Health in KSA

Name: Giovanni Formato			
Job Title:**	**Honeybee Diseases and Pests Consultant**		
Division/Department:	FAO KSA		
Programme/Project Number:	UTF/SAU/051/SAU		
Duty Station:	Riyadh, with travel within the Kingdom of Saudi Arabia (KSA)		
Expected Start Date of Assignment:	16th April 2022	**Duration:**	90 calendar Days (65 working days)
Reports to:	***Name:*** Dr. Kakolii Ghosh	**Title:**	FAO -KSA CTA

General Description of task(s) and objectives to be achieved

The Programme Management Unit (PMU) of the FAO-Saudi Technical Cooperation Programme (2019-2025) facilitates, coordinates and manages all technical and advisory services to be provided by FAO to the Saudi Ministry of Environment, Water and Agriculture (MoEWA). The project "UTF/SAU/051/SAU Strengthening MoEWA's Capacity to Implement the Sustainable Rural Agricultural Development Programme" is the first project that has been approved within the framework of FAO-Saudi Technical Cooperation Programme (2019-2025). The project will provide technical and advisory assistance to the MoEWA in implementing its flagship Sustainable Rural Agricultural Development programme that has recently been approved within the context of the National Transformation Programme of the Saudi Vision 2030. The project expected results will be achieved through implementation of nine project components: 1) Development of coffee Arabica production, processing and marketing; 2) Development of beekeeping and honey production; 3) Development of rose production and trade; 4) Development of sub-tropical fruits production, processing and marketing; 5) Strengthening capacity of small-scale fishermen and fish farmers; 6) Strengthening capacity of small-scale livestock herders; 7) Development of rain-fed cereals production; 8) Enhancing value addition from smallholdings and rural activities; and 9) Strengthening MoEWA's capacity in sustainable management of rangelands, forests and natural resources to support rural livelihoods.

To ensure a coordinated, smooth, timely and successful implementation of the project, long-term competent international technical advisors were appointed as Component Managers to each of the nine components. Each Component is supported by a team of international technical advisor, consultants and national experts who are technical specialists in the subject matters of the various outputs and activities of the respective component.

Prevalence of Honeybee disease and pests is one of the major challenges of the beekeeping sector in the country. The current outbreak of Nosema disease has impacted significant proportion of beekeepers in the country. The **Honeybee Diseases and Pests Expert (Team leader)** will contribute to the accomplishment of outputs of the project component on "Development of beekeeping and honey production". More specific, the consultant will carry out and lead the following tasks:

- Review the existing beekeeping industry in the Kingdom of Saudi Arabia, the management practices including different species, beekeeping practices (dedicated and non-dedicated beekeepers – rearing of imported packaged live honeybees), and assess their impact on honeybee's health in the KSA,
- Identify major diseases and pests affecting honeybees in the KSA and assess their impact, underlying causes of their presence and provide recommendation on assessment tools, approaches and techniques to limit their spread,
- Design and conduct study to assess the prevalence Nosema disease in the Kingdom of Saudi Arabia, its current geographical distribution, magnitude, and the underlying causes and suggest approaching, and methods to minimize its spread and impact,
- Prepare recommendations relating to ameliorating the impact of the Nosema on small scale beekeepers including options to provide direct material and or financial support,
- Lead the preparation of technical manual on diagnosis and control of honeybee disease and pests,
- Lead the preparation of technical manual on diagnosis and control of honeybee disease and pests,
- Contribute to workshops involving different stakeholders to discuss and validate the proposed national honeybee's health and disease control strategy,
- Lead the preparation of an IPM plan for the control of honeybee diseases and pests in the country,
- Contribute to the organization of workshop on honeybee diseases and pests,

Key performance indicators

Expected Outputs:	Required Completion Date:
• Report on honeybees health and major diseases and pests in the KSA.	3 weeks from commencement of the assignment
• Report on the presence of Nosema disease, its spread and impact in the country, and possible approaches and methods to limit its spread and impact	5 weeks from commencement of assignment

• National strategy for sustainable honeybee's health and disease control developed and validated.	9 weeks from the commencement of the assignment
• Technical manual on diagnosis and detection of honeybee disease and pests prepared	10 weeks from commencement of the assignment
• Honeybees IPM plan prepared and submitted	11 weeks from commencement of assignment
• Workshop on honeybee disease and pests conducted	12 weeks from commencement of assignment

Food and Agriculture organization of the United Nations

Terms of Reference for PSA.SBS Category B*

Name: Nasredeen Kamal Basuny			
Job Title:**	**Honeybee Apiary Management in Arid Lands Consultant**		
Division/Department:	FAO KSA		
Programme/Project Number:	UTF/SAU/051/SAU		
Duty Station:	Riyadh, with travel within the Kingdom of Saudi Arabia (KSA)		
Expected Start Date of Assignment:	21 May 2022	**Duration:**	15 August (65 working days)
Reports to: ***Name:***	Dr. Kakali Ghosh	**Title:**	FAO -KSA CTA

* Please note: If this TOR is for Consultant / PSA.SBS contract, the minimum relevant experience required **for the assignment** is as follows:

1 year for a category C; 5 years for a category B; 12 years for COF category A; 15 years PSA or COF category A (World Class Expert);

** Please enter a short title (max 25 chars) for this assignment.

General Description of task(s) and objectives to be achieved

The Programme Management Unit (PMU) of the FAO-Saudi Technical Cooperation Programme (2019-2025) facilitates, coordinates and manages all technical and advisory services to be provided by FAO to the Saudi Ministry of Environment, Water and Agriculture (MoEWA). The project "UTF/SAU/051/SAU Strengthening MoEWA's Capacity to Implement the Sustainable Rural Agricultural Development Programme" is the first project that has been approved within the framework of FAO-Saudi Technical Cooperation Programme (2019-2025). The project will provide technical and advisory assistance to the MoEWA in implementing its flagship Sustainable Rural Agricultural Development programme that has recently been approved within the context of the National Transformation Programme of the Saudi Vision 2030. The project expected results will be achieved through implementation of nine project components: 1) Development of coffee Arabica production, processing and marketing; 2) Development of beekeeping and honey production; 3) Development of rose production and trade; 4) Development of sub-tropical fruits production, processing and marketing; 5) Strengthening capacity of small-scale fishermen and fish farmers; 6) Strengthening capacity of small-scale livestock herders; 7) Development of rain-fed cereals production; 8) Enhancing value addition from smallholdings and rural activities; and 9) Strengthening MoEWA's capacity in sustainable management of rangelands, forests and natural resources to support rural livelihoods.

To ensure a coordinated, smooth, timely and successful implementation of the project, long-term competent international technical advisors were appointed as Component Managers to each of the nine components. Each Component is supported by a team of international technical advisor, consultants and national experts who are technical specialists in the subject matters of the various outputs and activities of the respective component.

Prevalence of Honeybee disease and pests is one of the major challenges of the beekeeping sector in the country. The current spread of Nosema disease has impacted significant number of beekeepers in target regions. The **Honeybee Apiary Management in Arid Lands Consultant** will contribute to the accomplishment of outputs of the project component on "Development of beekeeping and honey production". More specific, the consultant will carry out and contribute the following tasks:

- Review the existing beekeeping management practices and assess the current situations of honeybee's health in the KSA,
- Identify major challenges facing beekeeping and honey production in the Kingdom, including climatic and forage and feeding practices, and assess their impact on the honeybee's health,
- Suggest and design options to ameliorate/limit stresses on honeybees and to mitigate the impact of adverse climatic conditions and shortage of honeybee forage including the introduction of appropriate shading, supplementary feed and feeding schemes,
- Contribute to the identification of pest and diseases affecting honeybees in the KSA, assess its magnitude and specify possible underlying causes provide recommendation on approaches and techniques to limit their spread,
- Assess the possible prevalence Nosema disease, assess its spread and impact in the country, identify underlying causes and suggest approaches and methods to limit its spread and impact,
- Study current situation of live honeybees and related feed and ingredients imports and importation procedures, assess their impact on honeybees and beekeeping industry,
- Provide recommendation on appropriate quarantine and regulations to improve situation and ensure the health and productivity of the local honeybees,
- Benchmark best practices for design of national honeybee's health and disease control strategies and elicit lessons to be learnt.
- Adopting consultative produces, draft national strategy for honeybee health and disease control that provides for detection, surveillance and early warnings, for KSA,
- Conduct workshops involving different stakeholders to discuss and validate the proposed national honeybee's health and disease control strategy,
- Contribute to the preparation of technical manual on diagnosis and control of honeybee disease and pests, and ensure the preparation of an Arabic version,
- Prepare an IPM plan for the control of honeybee diseases and pests in the country,
- Conduct workshop on honeybee diseases and pests,
- Assess and report the impact of Nosema disease on small holder beekeepers.

key performance indicators

Expected Outputs:	**Required Completion Date:**
• Contribution to the report on the prevalence of major honeybee diseases and pests and the current situation of honeybee health in the KSA prepared	3weeks from the commencement of the assignment
Appropriate quarantine approaches and requirements for importation of live bees and materials will be prepared	6 weeks from the commencement of the assignment
• National strategy for sustainable honeybee's health and disease control developed and validated.	9 weeks from the commencement of the assignment
• Appropriate feeds and feeding schemes to minimize the stress of honeybees colonies prepared	10 weeks from the commencement of the assignment
• Contribution to IPM and Technical manual on diagnosis and detection of honeybee disease and pests prepared in Arabic	11 weeks from the commencement of the assignment
• Workshop on honeybee disease and pests conducted	12 Prepare technical manual on diagnosis and detection of honeybee disease and pests

برنامج التعاون الفني بين وزارة البيئة والمياه والزراعة ومنظمة الأغذية
والزراعة للأمم المتحدة، الرياض، المملكة العربية السعودية
ص. ب.: 558 الرياض 11421
بريد إلكتروني: FAO-SA@fao.org