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Short and long-term intervention approaches for control and prevention of the adult honeybee fungal disease (Nosemosis) in the KSA BEE/051/2022/1

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

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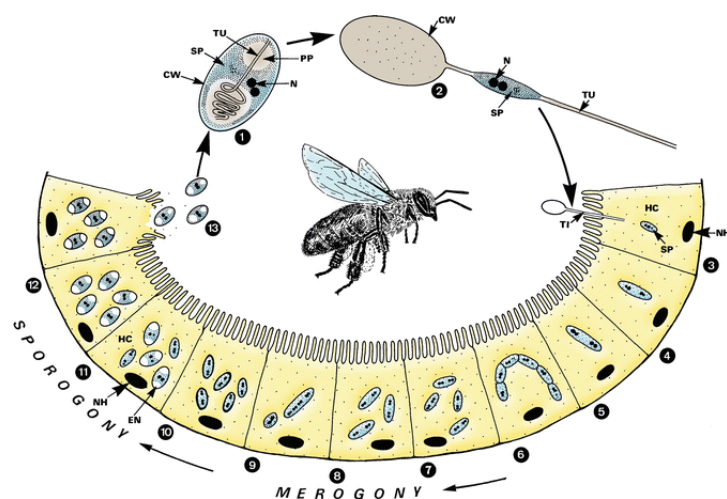
1. Introduction

Currently beekeeping is practiced in all regions of the country by a wide range of people living in rural and semi urban areas as sole occupation or as sideline activity. In the country, about 5 000 beekeepers are managing about one million local bees and over one million annually imported exotic package bees. In the country both traditional and modern beekeeping are widely practiced. Beekeeping besides its role in serving as source and diversification of livelihoods options and it has several comparative advantages under Saudi Arabia context. It is one of climate change resilience agricultural activity, contributes for sustainability of environment and rural development, mitigate climate changes, it is useful in combating desertification and conservation of biodiversity. Moreover, beekeeping can be integrated with other agricultural and natural resource management activities without competing for scarce resources water and arable land in the country. Despite its several comparative advantages and potentials for development, the beekeeping sector is hampered by several challenges of which the spread of honeybee diseases and pests and associated declining of honeybee population and productivity of bee colonies are the major one. This short document is prepared as part of the FAO-KSA contribution to response the current outbreak of adult honeybee disease (Nosemosis) in most beekeeping potential regions of the KSA. The report provides brief introduction about the history of the disease and short, medium and long-term intervention measures.

Nosemosis is worldwide adult honeybee disease caused by two different species of fungus *Nosema apis* and *Nosema ceranae*. *N. apis* is known to affect honeybees nearly for a century while *N. ceranae* is a recently reported in 1996. The diseases propagate by spores which are resistant form of the species. The pathogens are obligate parasites of the intestine of adult honeybees. Infection of the bees mainly occurs by the oral ingestion of spore-contaminated honey, pollen or water, faeces and by means of trophallaxis. The spores of the two species are morphologically indistinguishable, however *N. apis* spores are fatter and more rounded at the ends (similar to rice grains) than spores of *N. ceranae*, which tend to be more tapered. The spores can remain infectious for up to 5 years. Nosemosis can be aggravated by different stresses, scarcity of honey and pollen, seasonal weather conditions, and the presence of other diseases (varroa, viruses and amoeba). *Nosema apis* was first detected in Saudi Arabia in 1989 in six apiaries and *Nosema ceranae* was reported in the country for the first time in 2017 in eight locations. These indicate that Nosemosis is prevalent in the country since many years. The introduction and dissemination of various honeybee disease in the country believed to be due to mass introduction of exotic bees, importation of bee collected pollen, absence of strong quarantine system to prevent the introduction of honeybee pathogens.

2. The life cycle of Nosema

When the bees ingest the *Nosema* spore with contaminated food source, the spore within minutes their polar filaments become active and penetrate the epithelium of the host (Fig. 1). Then, it travels using its polar filament to enter the host cell and the spore becomes active (feeding) stage and then undergo binary division (asexual reproduction). Then they continue to reproduce to become large number and finally the host cell will rupture and the spores pass in to host faeces. These spores again reinfest other host cells and finally causes the death of the bees.



Source: © Springer life science

Fig. 1. The life cycle of *Nosema*

3. Symptoms of *Nosema* disease

3.1 Symptoms of *Nosema apis*

N. apis is spread in cold and wet areas particularly in winter and spring seasons. After ingested the spores develop in the intestine of the bees very fast affecting their digestive system and preventing the absorption of nutrients. Some of the major symptoms *N. apis* are:

- ✓ Diarrhea can be observed on hive entrance and on honeycomb that smeared by faeces of infected bees (Fig.2),
- ✓ Bees unable to produce royally jelly and unable to feed brood that lead declining of the population,
- ✓ Foraging activity gradually declining and stop completely,
- ✓ Some bees unable to fly and paralyzed,
- ✓ The abdomens of dead bees are swollen,



Fig. 2 Symptoms of *Nosema apis*

3.2 Symptoms of *Nosema ceranae*

The interaction of *N. ceranae* is different from *N. apis* which only invades the gut, but *N. ceranae* can penetrate the gut wall and invade other tissues. However, it has no clear observable symptoms like diarrhea and affects the bee colonies without being easily noticed by beekeepers. Some of the common symptoms of the *N. ceranae* are:

- ✚ The disease can occur throughout the year, even in warm climatic conditions,
- ✚ It is known by the absence of diarrhea,
- ✚ The infected bees die away from the hive (not returning)
- ✚ The population gradually decline and totally loss without noticing the presence of dead bees in the hive

Both diseases are well detected by only a laboratory microscope test for the presence of spores at the intestine of the infected adult bees following simple diagnostic procedures. The two species can be differentiated by only molecular level using PCR analysis.

4. The current outbreak of Nosemosis in the Kingdom of Saudi Arabia

As the oral explanation of the beekeeper's representatives, the symptoms they explained are well associated with the honeybee disease *Apis ceranae*. The report from the Al-Baha beekeeper's Cooperative's bee samples lab analysis also confirmed the disease is *A. ceranae*. As their reports, the distribution of the disease covers very wide areas affecting most of the beekeeping potential regions of the country, Jazan, Aseer, Al-Baha, Makkah, Al-Madinah, Hail and Tabuk. According to the report of the beekeeper's representative, most beekeepers have lost about 60-90 % of their honeybee colonies.

Even through, the prevalence of the disease is reported many years back in the country, its outbreak in such magnitude in this season can be associated with some aggravating factors such as shortage of rain and associated limited pollen source bee forages in Autumn and Winter seasons. The bee colonies were in continuous stress starting from the last summer stress, followed by Sidr (*Ziziphus*) honey flow period which put the bees in stress because *Ziziphus* is known for limited pollen source then it followed by

this year Autumn drought (in Tahama) and the major pollen source plants were not available to the bees as very commonly found in the past. These external environmental factors coupled with inadequate bee management practices of beekeepers believed to create conducive environmental conditions for the Nosemosis to manifest itself in the form of outbreak which is very common phenomenon of the disease elsewhere in the world.

5. Short, medium to long term recommendations to control the spread of the nosema disease

The recommendations suggested below are both short-term and medium to long-term. The short-term suggestions are those focus areas that need for immediate actions to contain the spread of the disease and the death of the bee colonies. The medium to long-term recommendations are to sustainably control and prevent the disease following international best practices.

5.1 Short-term recommendations

Considering the degree of the distribution (area coverage) and the magnitude of the death rate, the impact of the disease seems very serious, and it needs very urgent control measures to contain and limit the spread of the disease and stop the death of the bee colonies. Some of the short-term recommendations are:

- 1. Conducting of rapid diagnostic survey:** Conducting very urgent diagnostic survey following a standard procedure to cover larger areas and to estimate the degree of infestation, economic impact and also to identify the other associated pathogens or chronic exposure to phytoterapeutical products (pesticides) are very important. It is essential to collect and preserve sufficient bee samples not only to detect Nosema but also to identify all possible spectrums of bee pathogens which is useful to know the other associated diseases (virus and varroa) which is important to take integrated control and preventive measures. It is good to make the survey with composed of professionals with standard check list not only to take samples, but to also record the status of the colony and apiary management practices to establish correlations and to forward appropriate bee colony management measures. The sampling procedures should be systematic to include or represent all colonies in apiary even with no sign of Nosemosis. This is because the pathogen may harbor in healthy colony and apiaries.
- 2. Temporarily restriction of the movement of bee colonies:** The bee colonies from the infected areas should not be moved to other non-infected areas for at least the coming 2-3 months and also bee colonies from non-infected areas should not be moved into infected areas.
- 3. Applying available treatment measures:** As the reports of the beekeepers the death rate is very alarming, so it is very important to use available effective treatments to stop the death of the bees and its further spread.

The common available and effective antibiotic to treat Nosemosis is Fumidil B-Mann Lake (Fumagillin), which is commonly used by some beekeepers in the country, and it is also registered and allowed both in USD and Canada. But Fumagillin is not recommended in Europe because of its possible residual effect on honey and other bee products. However, report showed in several European countries (UK, Spain, Belgium, Greece, Hungary, Romania etc.) when there was high prevalence of colonies infected by *N. ceranae*, exceptional temporary authorization has been given to use fumagillin under veterinary supervision to treat noseamosis in positively diagnosed apiaries (Higes *et al.*, 2011).

However, under local conditions for the sustainability of the treatment, Priority should be given for organic control methods with alternative and effective commercially available organic acids, phytotherapeutics and essential oils than antibiotics. Such type of treatment should be integrated with good bee management practices (supplementary feeding).

4. **Implement management measures to revitalize the affected colonies:** Since the disease manifests itself under the bee's stress conditions it highly recommended beekeepers to feed the bee colonies with Nosema spores free supplementary feeds (Gamma ray and heat-treated pollen and pollen substitutes and sufficient sugar syrup). Moreover, some common bee vitalizing natural products such as Nozevit Plus and other should be feed to all bees.
5. **Disinfect contaminated hives, frames and burning of combs:** to stop the spread of the disease and to avoid reinfection of colonies all contaminated hives, frames, tools and equipment should be disinfected either using boiled water > 60°C or by torching using gas flames. All wax combs either should be melted to be reused or burned or buried in below 50 cm depth ground.
6. Based on the degree of the damage caused by the disease, MoEWA can make assessment on the economic impact of the disease and if it is very significant some means of compensations can be studied and provided.

5.2 Medium to long-term recommendations

The medium and long-term recommendations are focused on sustainable control/prevention measures of the disease that focuses on reduction of the disease incidence, prevalence, morbidity and mortality to acceptable level. Moreover, applying "integrated pest management strategy" that is Good Beekeeping Practices (GBP) and Biosecurity Measures by beekeepers is very essential.

5.2.1 Strategic policy measures to control of the of noseamosis and other honeybee diseases

Developing a national honeybee health and diseases management, prevention and control strategy is very important and should be given first priority to guide all intervention directions. The strategy can be developed following international best practices and success stories. In this regard, FAO-KSA can

recruit international experts to work with national partners to develop the strategy. The strategy may include the following points

- Temporary or total restriction of importation of live package bees,
- Total or conditional restriction of the importation of bee collected pollen,
- Banning of the introduction of any used bee materials and equipment,
- Implement strong quarantine system to prevent the introduction and dissemination of honeybee diseases,
- Applying registration of appropriate honeybee veterinary drugs and bee feeds and restrict non-authorized ones,

5.2.2 Strategic policy measures to strengthen local capacities

- Design and implement regular honeybee disease surveillances for early detection and early warning system,
- Strengthen local veterinary service and diagnostic laboratory provisions,
- Develop national honeybee breeding program of nosema-resistant bees and improve the local bee breeds towards resistance to major honeybee diseases through selection and genetic improvement programme,
- Strengthen the local queen rearing and supplying capacity of the country to satisfy the local honeybee colony demands and to regularly replace the old queens by establishing and operationalizing the new and existing queen rearing centers
- Raise the awareness of beekeepers towards knowledge and prevention measures of honeybee diseases and pests

5.2.3 Good Beekeeping Practices and Biosecurity Measures in Beekeeping

Currently in many countries the honeybee disease control measures are based on integrated approaches that focus on Good Beekeeping Practices and Biosecurity Measures in Beekeeping (BMB). GBP are those integrative approaches that beekeepers follow in apiary management to achieve optimal health of honeybees, humans and environment. BMBs are all apiary management activities required to be implemented by beekeepers to minimize the risk of introduction and dissemination of specific honeybee disease agents. The recommendations mentioned below are based on the recent FAO documentations and reviewing of the latest available publications pertinent to the control and prevention of Nosemosis. Some of the major GBP and BMBs that are currently recommended to be implemented by beekeepers are listed below.

5.2.4 GBP and BMBs based on international practices

- a) Avoid using of combs originated from absconded or collapsed colonies,

- b) Remove and destroy combs with signs of dysentery or suspected to infected with Nosema,
- c) Disinfect contaminated hives and frames with gas-flames before reusing them,
- d) Replace the queens, except those with high genetic value, maximum every two years,
- e) Take samples of forager bees in early Autumn or spring and send to laboratory for diagnosis,
- f) Adopt proper control measures for other associated honeybee pathogens like *Varroa destructor* because Nosemosis is aggravated in the presence of other pathogens,
- g) Strengthen and stimulate bee colonies through sufficient supplementary feeds and vitamins,
- h) Avoid or minimize the robbing and drifting of bees in apiary which are important means of spreading of the Nosema spores,
- i) Do not reuse combs originating from depopulated or collapsed hives,
- j) Disinfect all beekeeping tools and equipment every after use applying: torching (*Nosema ceranae* spores are inactivated over 60 °C), gamma radiation, fumigations of combs with glacial acetic acid, sodium hypochlorite 0.5% (bleach) and ammonium hydroxide 1.65% (ammonia solution) or sodium hydroxide 5% (caustic soda),
- k) Avoid feeding of colonies with honey or pollen obtained from Nosema infected colonies,
- l) Avoid moving combs in other colonies from Nosema infected colonies,
- m) Keep new colonies from other sources isolated and monitor their health status before introduction,
- n) Remove and disinfect dead colonies as soon as possible,
- o) Renew 30% the hive combs every year,
- p) Avoid the stress of bees with proper protein and carbohydrate feeds,
- q) When the infection level is >100 000 spores/bee treat the colony with available and registered products or feed them with integrators/feed supplements
- r) Adjust the volume of the hive to the population size of the bees and remove all unoccupied combs,
- s) Provide the bees, if needed, clean water,
- t) Prevent pollution of water sources with faeces or drowned or dead bees.

5.2.5 GBP and BMBs recommendations based on local apiary management practices

There are apiary management practices which are peculiar to local conditions that require recommendations in relation to the local practices. Some of such recommendations are:

1. Keeping optimum distances (1-2 km) between different adjacent apiaries to minimize the spread of the disease. In the country it is very common to keep different apiaries very close each other and sometimes different beekeepers keep their colonies in one apiary site.

2. Split large number of colonies and keep them in different apiaries. It is very common practice in the country to keep 300-600 colonies in one apiary that aggravate the rapid spread of the diseases.
3. Avoid external (common) feeding and watering that leads to easily contamination of the feed and fast spread of the disease among all colonies in apiary. Apply internal feeding (e.g. using candy feeds) and watering even in local hives.
4. Keep fewer strong and productive colonies than keeping large number of weak, unproductive and unhealthy colonies. Beekeepers in the country tend to keep large number of colonies regardless of their productiveness.

In this regard the awareness of beekeepers towards ethical, GBP and BMBs should be raised through extensive training and strong awareness creation campaigns.

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6. Annex: Short term and long-term interventions in tentative time frames

Short term interventions	Tentative time frame
Conducting of rapid diagnostic survey	25-02-22 - 30-03-22
Temporarily restriction of the movement of bee colonies	25-02-22 - 30-05-22
Applying available treatment measures	25-02-22 - 30-05-22
Implement management measures to revitalize the affected colonies	25-02-22 - 30-05-22
Disinfect contaminated hives, frames and burning of combs:	25-02-22 - 30-05-22
Medium and long-term strategic policy measures	
Develop national honeybee health monitoring programmes and disease management, prevention and control strategy	01-09-22 – 01-06-23
Temporary or total restriction of importation of live package bees,	25-02-22 - 30-05-22
Total or conditional restriction of the importation of bee collected pollen,	25-02-22 - 30-05-22
Banning of the introduction of any used bee materials and equipment,	25-02-22 - 30-05-22
Implement strong quarantine system to prevent the introduction and dissemination of honeybee diseases,	25-02-22 - 30-05-22
Applying registration of appropriate honeybee veterinary drugs and bee feeds and restrict non-authorized ones,	01-09-22 – 01-06-23
Strategic policy measures to strengthen local capacities	
Design and implement regular honeybee disease surveillances for early detection and warning system	25-02-22 onward
Strengthen and training of local veterinary service provisions and diagnostic laboratories,	25-02-22 onward
Develop national honeybee breeding program and improve the local bee breeds towards resistance to major honeybee diseases, including noseosis	01-03-22 -30-10-22
Strengthen the local queen rearing and supplying capacity of the country to satisfy the local honeybee colony demands	25-02-22 onward
Raise the awareness of beekeepers towards mortality of bees, prevention and control measures of honeybee diseases and pests	25-02-22 onward
Training and implementation of all Good Beekeeping practices and Biosafety Measures in Beekeeping, including monitoring activities and trademarks	25-02-22 onward



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