International Partnership on Innovation

SAMS - Smart Apiculture Management Services

Deliverable N° 5.2

Bee-Management and Bee-Health database

N° 5 - Api Management

Horizon 2020 (H2020-ICT-39-2017)

Project N°780755

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SAMS consortium partners

Logo	Partner name	Short	Country
	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (Coordinator)	GIZ	Germany
	University of Kassel	UNIKAS	Germany
	University of Graz (Institute for Biology)	UNIGRA	Austria
	Latvia University of Life Sciences and Technologies	UNILV	Latvia
	ICEADDIS – IT-Consultancy PLC	ICEADDIS	Ethiopia
	Oromia Agricultural Research Institute, Holeta Bee Research Center	HOLETA	Ethiopia
	University Padjadjaran	UNPAD	Indonesia
	Commanditaire Vennootschap (CV.) Primary Indonesia	CV.PI	Indonesia

Summary of the project

SAMS is a service offer for beekeepers that allows active monitoring and remote sensing of bee colonies by an appropriate and adapted ICT solution. This system supports the beekeeper in ensuring bee health and bee productivity, since bees play a key role in the preservation of our ecosystem, the global fight against hunger and in ensuring our existence. The high potentials to foster sustainable development in different sectors of the partner regions are they are often used inefficient.

Three continents - three scenarios

(1) In Europe, consumption and trading of honey products are increasing whereas the production is stagnating. Beside honey production, pollination services are less developed. Nevertheless, within the EU 35% of human food consumption depend directly or indirectly on pollination activities.

(2) In Ethiopia, beekeepers have a limited access to modern beehive equipment and bee management systems. Due to these constraints, the apicultural sector is far behind his potential.

(3) The apiculture sector in Indonesia is developing slowly and beekeeping is not a priority in the governmental program. These aspects lead to a low beekeeper rate, a low rate of professional processing of bee products, support and marketing and a lack of professional interconnection with bee products processing companies.

Based on the User Centered Design the core activities of SAMS include the development of marketable SAMS Business Services, the adaption of a hive monitoring system for local needs and usability as well as the adaption of a Decision Support System (DSS) based on an open source system. As a key factor of success SAMS uses a multi stakeholder approach on an international and national level to foster the involvement and active participation of beekeepers and all relevant stakeholders along the whole value chain of bees.

The aim of SAMS is to:

- enhance international cooperation of ICT and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal (SDG N°2) “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”
- increases production of bee products
- creates jobs (particularly youths/ women)
- triggers investments and establishes knowledge exchange through networks..

Project objectives

The overall objective of SAMS is to strengthen international cooperation of the EU with developing countries in ICT, concentrating on the field of sustainable agriculture as a vehicle for rural areas. The SAMS Project aims to develop and refine an open source remote sensing technology and user interaction interface to support small-hold beekeepers in managing and

monitoring the health and productivity in their own bee colonies. Highlighted will be especially the production of bee products and the strengthening of resilience to environmental factors.

- Specific objectives to achieve the aim:
- Addressing requirements of communities and stakeholder
- Adapted monitoring and support technology
- Bee related partnership and cooperation
- International and interregional knowledge and technology transfer
- Training and behavioral response
- Implementation SAMS Business cooperation

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Executive summary

The beekeeping situation in Europe, Ethiopia and Indonesia strongly differs from each other. While there exist whole books and journals dealing with the European beesector, beekeeping and bee species, in Indonesia and Ethiopia by far less literature and public attention are available. Ethiopia and Indonesia are rich in flora and fauna and have high potential in beekeeping and honey production. Developing the bee sector in those countries may lead to a strong trading partnership with the EU, who is known to be a net-importer of honey and honey bee products. For this reason, in the first months of the SAMS project, within work package 5 (Api-Management), deliverable 5.1 (Bee-Management and Bee-Health Indicators), we contextualized the situation of honey bees and beekeeping in the two target countries Ethiopia and Indonesia. The findings were based on a scientific literature study, complemented by expert opinions from the two countries. In summary, we were able to use content from 114 different literature sources for deliverable 5.1. As already mentioned in the last deliverable 5.1, many scientific publications in English language on beekeeping, bee forage or honey bee health exist for Ethiopia, but for Indonesia fewer information was available.

As contextualizing in this aspect is an ongoing process, we were aiming to create a growing digital knowledge database and thus the situation of bees and beekeeping in the two target countries was not completed with the preliminary report. As a consequence, we were able to identify 25 more topic related literature sources (totaling in 139 cited research articles) since the last submission and further we focused more on expert opinions for the database presented in this deliverable. The collected information (including references) was made publicly available by creating a glossary database – the SAMSwiki. The reviewed knowledge was structured by assigning them into a total of 8 main chapters and 39 subchapters.

The SAMSwiki serves as a wiki like approach that allows further extensions by consortium members, researchers or any interested people and even future adaptions like the translation of the content to local languages to support the dissemination of knowledge gained within SAMS or already available from other research. The database acts also as a strong tool for European beekeepers and researchers to gain and exchange knowledge with non-European countries and may bring up new ideas to further develop European beekeeping. With this deliverable, an instruction on using the SAMSwiki is given and so far identified knowledge as well as knowledge gaps are summarized. Despite we were able to reduce the number of knowledge gaps since the last deliverable 5.1, there is still plenty of research necessary to well describe the Ethiopian and Indonesian beesector and local beekeeping.

SAMSwiki website: https://wiki.sams-project.eu/index.php/Main_Page

1. Results of the literature study

In general, we were able to identify a higher amount of English language literature dealing with the beekeeping situation in Ethiopia, than that of Indonesia. Besides the limited available literature, another challenge was the diverse “scientific quality” of available scientific publications. These quality differences ranged from wrong spelling of species to substantively wrong statements. Latter literature was not considered for the database presented in this document. Hence, not every literature source, dealing with the demanded topics, was suitable for our purpose.

As already mentioned, the collected results on bees, beekeeping and the beesector of the two target countries, including their references, are publicly available in form of a glossary on our SAMSwiki website: https://wiki.sams-project.eu/index.php/Main_Page. To present an overview, in the following chapter the main topics and their outcome are summarized.

1.1. Key numbers of apiculture

This chapter deals with basic statistical parameters like the size of human population, the country area’s size, the number of hives and beekeepers within the particular country, or ratio of those key numbers like the number of beekeepers per area, etc. Further topics within this chapter are native honey bee species and subspecies, as well as non-*Apis* managed bees used for bee products.

1.2. Honey bee products and honey bee sector

Bees do not only produce honey, but also other very valuable products like beeswax, pollen, propolis, beebread or even bee brood can be considered as a "product". Within this chapter the following keywords are discussed: honey (production, honey market value chain), beeswax (statistics, use, …), pollen (statistics, use, …), propolis (statistics, use, …), import and export quotes of bee products, and the products’ prizes. While there exists a cryptic market for pollen and propolis in Indonesia, Ethiopia's beesector mainly focuses on honey and to some point on beeswax. Summarizing the data provided from FAO, Ethiopia can be regarded as a net exporter of honey (mostly to Europe), whereas Indonesia is a net importer (mostly from Asia). Prizes of bee products also differ greatly between target countries and even between regions.

1.3. Bee forage

The following chapter covers topics like local climate, number of melliferous plants and important literature, and major honey flows (plants, seasons). Nectar and pollen are key resources for honey bees and bees must be able to find sufficient quantity and quality within their foraging radii. The foraging radius depends on the bee race, the local climate as well as on the environment, but a benchmark of 3 km can be expected for European *A. mellifera* colonies. Not every blooming plant produces nectar AND pollen and they differ in terms of nectar and pollen production (protein content, quantity, quality and flowering time). In a consequence, a high diversity of bee forage around the apiary is from high importance for honey bee health and in a broader sense for the income of the beekeeper. The tropical climate of Ethiopia and Indonesia enables a high diversity in flora and fauna. While important literature on honey bee forage for Ethiopia exists and needs to be published for Indonesia, floral calendars for both countries are missing.

1.4. Beekeeping

The chapter beekeeping deals with the following topics: honey bee species used for beekeeping, other types of gaining bee products including honey hunting and meliponiculture, hive types, bee hive manual of Deliverable 3.1 from Holeta Bee Research Center (Ethiopia), hive management (supplemental feeding, prevention of swarming, …), locally adapted hive management interventions (good beekeeping practice), biggest problems in beekeeping, status of migratory beekeeping, status of pollination business and beekeeping associations. Beekeeping or apiculture is the housing and maintaining of bees, mostly of the genus *Apis*, in hives. Not only the choice of the right honey bee race, but also the right hive-system and appropriate hive management contribute to successful and high profitable honey bee product yields. In this chapter honey bees that are used for beekeeping in the two target countries, as well as commonly used hive types and hive/colony management were assessed. In both target countries, the use of mostly traditional hive systems is common. In both countries the hive management plays a subordinate role, which means, that methods like supplementary feeding, requeening, swarm prevention or bee health management is not common in every region of the countries. Besides classical beekeeping, honey hunting and the use of stingless bees (meliponiculture) are widely practiced to gain bee products. The research results also indicated, that there is no nation-wide good beekeeping practice and no pollination business at all. There are few beekeeping associations and their structure differ from those of Europe. Constraints and problems regarding the beekeeping sector were also assessed resulting in a variety of problems, from lack of knowledge about bee biology to a lack of market or finance facilities.

1.5. Bee pathology

Within the chapter bee pathology the following topics are discussed: a general overview of honey bee health (presence of pests/pathogens and predators), a various amount of organisms and diseases affecting the honey bee health (viruses, foulbrood, *Nosema*, chalkbrood, wax moths, bee lice, coleoptera, ants, parasitic mites, tracheal mites, and others), methods of local beekeepers to deal with honey bee health issues, commonly (if any) applied treatments of different pests, threats for the introduction of new pests, and education and dissemination. There are numerous pests, pathogens and predators which affect the health of honey bee colonies and further may cause economic loss. Therefore, it is important for beekeepers to know about existing threats and how to treat a possible infestation. In the following chapter, an assessment on honey bee health status, major pests and predators and local treatment methods was conducted. Summarized, there is a wide variety of pests and pathogens that affect honey bee health in Ethiopia and Indonesia. They range from viruses, protozoa, bacteria, fungi and insecta to mites and mammals. In general, the research indicated that beekeepers in both countries underestimate the risk of honey bee diseases and that treatment methods, that are commonly used in the western world are unknown in Ethiopia and Indonesia. It is necessary to work on education dissemination to enlarge the understanding of honey bee biology and further increase the income.

1.6. Possibilities for smart bee management (Precision Beekeeping)

The chapter possibilities for smart bee management deals with Precision Beekeeping and the possibilities to identify threshold values for honey harvest, or swarming events by using ICT solutions. To assess the status of a honey bee colony, the beekeeper needs to visually inspect the inside of the hive. This procedure is time consuming and may stress the colony. The active monitoring and remote sensing by appropriate ICT solutions (Precision Beekeeping) may be a useful tool to support the management of honey bee health, colony development and even the bee productivity. One practice for Precision Beekeeping is the use of Decision Support Systems. Without sufficient data analysis it is not possible to get added value from different bee colony measurement systems. A Decision Support System (DSS) can be adapted for the Precision Beekeeping for automatic data analysis and is considered as one of the sub-systems of the Precision Beekeeping. Using different algorithms and models, DSS can help the beekeepers to identify different bee colony states and warn about abnormal situation of the colony. Different bee colony states may have different levels of importance and can be identified with different levels of reliability. DSS can process and combine data related to the bee colony weight, temperature, sound etc. DSS decisions can be split into two groups: individual rules,

which are based on single colony monitoring and differential rules, which are based on comparison of different colonies within one apiary.

2. Knowledge gaps

Based on the evaluated literature and expert interviews, the following knowledge gaps were identified and need further research attention. Especially bee hive management and bee health issues are not well investigated or documented and an assessment of statistically important key numbers is missing in both target countries and therefore are in need of further research. All the following mentioned knowledge gaps are also available on the SAMSwiki database.

2.1. Ethiopia

In general, with the Holeta Bee Research Center and other institutions, the scientific efforts on local honey bees and the Ethiopian beesector are rising, but there are still many knowledge gaps:

- General key numbers and statistical data on the number of hives in the country, or the annual honey production rate, as well as import and export quotes are well described, but there is still a lack of basic information, for example the number of beekeepers in the country is based on estimations.
- Based on the literature, there seems to be a beeswax business, and beeswax import and export quotes are published, but information on the use of beeswax or statistical data on the production rate within the Ethiopian population is not described.
- There are scientific studies dealing with increasing propolis yield, but information on a propolis business, how it is used, or if local beekeepers collect the product was not available.
- There is important literature available describing melliferous plants, but a floral calendar of important bee forage is missing.
- A big issue is missing information on hive management practices in Ethiopia. There is fragmentary published data available, but firstly none of them describes nationwide practices and secondly, about 95% are traditional beekeepers and therefore hive management, as we know it in Europe may not be possible in traditional hives. Nevertheless, to verify that, scientific research is necessary. Furthermore, in the existing literature sometimes there seems to be a misunderstanding when it comes to the difference of “reproductive swarming” and “absconding” of honey bees. Similarly, the evaluated bee health management knowledge is based on personal communication with local experts, but no records were available.

- According to a local expert, good beekeeping practice, similar to European standards exist within the country, but it is considered to be underdeveloped and needs further research.
- It was not possible to assess the migratory beekeeping status due to missing literature (is it practiced at all, how, …).
- Based on personal communication, there seems to be no pollination business at all. Published data is missing.
- In general, basic information on the presence of honey bee pests/pathogens and predators affecting the honey bee health is described, but especially when it comes to possible treatment methods, almost no literature based knowledge is available.
- No studies on honey bee viruses were available (presence, distribution, severity, ...).
- No studies on foulbrood were available (presence, distribution, severity, ...), but the disease exists in neighbouring countries and therefore it is a question of time until *Paenibacillus larvae* and/or *Melissoccocus plutonius* cross the boarders.
- *Nosema apis* is present in Ethiopia, but no studies on *N. ceranae* were available (presence, distribution, severity, ...).
- Parasitic mites like *Varroa destructor* are present, but no studies on *Tropilaelaps* spp. were available (presence, distribution, severity, ...).
- The methods of local beekeepers on how to deal with honey bee health issues are only based on personal communication with local experts and published literature is missing.

2.2. Indonesia

Compared to the other target country Ethiopia, in general fewer (English) literature is available for Indonesia. In Indonesia, the relationship between local people and bees is not based on strong traditionalism as in Ethiopia. Expert interviews revealed that many Indonesian people have certain prejudices against bees. Those range from fear of bee stings, to a lack of know how on the importance of bees as pollinators. This might be the reason, why study programs on national honey bees and the national beesector barely exist.

- Basic statistical information on beekeeping is missing (number of beekeepers, no. of hives, amount of produced honey, etc...).
- *A. mellifera* was introduced to Indonesia, but morphological and genetic studies are needed to identify the origin(s) of the introduced *A. mellifera* subspecies.
- Honey production statistics are missing or are only based on estimations. Studies on the assessment of honey quality exist, but they are not up to date anymore (prior 2000).

- The described structure of Indonesia's honey market value chain is only based on personal communication with local experts. No publications were available.
- It was not possible to find information on a possible beeswax business (statistics, use, ...).
- A pollen business in the country exists, but related information is only based on personal communication with local experts. No publications were available
- Based on personal communication, a propolis business exists, but no statistics or further details were available.
- Almost no literature deals with important melliferous plants and a floral calendar is missing at all.
- Information on honey harvesting season(s) is/are not well described and only based on personal communication with local scientists. No studies were available.
- Based on the evaluated literature, it was not clear which hive types are commonly used or what was the difference between modern and traditional hive-systems. Based on personal communication with local scientists, self-constructed hives are also considered as traditional, even though they were movable frame hives.
- A big issue is missing information on hive management practices in Indonesia. There is fragmentary published data available, but the information is not representative for the whole country. Furthermore, and as already mentioned for Ethiopia, in the existing literature sometimes there seems to be a misunderstanding when it comes to the difference of "reproductive swarming" and "absconding" of honey bees. Described knowledge on bee health management practices is only based on personal communication.
- Good beekeeping practice rules in Indonesia are non-existing.
- Migratory beekeeping with *A. mellifera* exists, but the information is only based on personal communication with local experts and detailed information is missing. No studies were available.
- Studies dealing with beekeeping problems and constraints are missing, but it is assumed, that Indonesia has similar problems as Ethiopia.
- Many Indonesian people do not know about the importance of bees as pollinators resulting in a lack of pollination business and a lack of regimentation of hive placement. Many local farmers do not permit bee hives next to their fields. Further research and education are necessary.
- Beekeeping associations exist, but their structure is not comparable to European associations. Literature is missing.
- When it comes to pests/pathogens and predators affecting the health of honey bees, there is only few literature available. This not only concerns possible treatment methods through beekeepers, but also basic information like the presence of a certain disease in Indonesia.
- No studies on honey bee viruses were available (presence, distribution, severity, ...).

- No studies on *Malpighamoeba mellificae* were available (presence, distribution, severity, ...).
- No studies on birds affecting the honey bee colony's size were available (species, distribution, severity, ...).
- No studies on foulbrood were available (presence, distribution, severity, ...).
- *Nosema ceranae* is present in Indonesia, but no studies on *N. apis* were available (presence, distribution, severity, ...).
- No studies on chalkbrood disease were available (presence, distribution, severity, ...).
- No studies on wax moths were available (presence, distribution, severity, ...).
- No studies on bee lice were available (presence, distribution, severity, ...).
- No studies on small, or adult large hive beetles were available (presence, distribution, severity, ...).
- Information on the methods of local beekeepers on how to deal with honey bee health issues are only based on personal communication and very cryptic.
- We do not know, how and if local beekeepers treat their honey bee colonies in case of an infection. No publications were available.
- No information on institutions, who offer nationwide education and dissemination of beekeeping related topics were available

3. How to use the SAMSwiki

The SAMSwiki is a publicly available database dealing with bees and beekeeping in Ethiopia and Indonesia and has the approach of a continuously growing knowledge database. Not only consortium members, but also researchers or any interested people are invited to contribute content to existing topics or to create new chapters. With the submission date of this deliverable, only consortium members are able to add content, but in the near future, permission will be given to the public.

With the following introduction, readers are able to create accounts and to add content to the SAMSwiki.

1) **Visit the website (figure 1): https://wiki.sams-project.eu/index.php/Main_Page**

Figure 1: Main page of the SAMSwiki and its navigation bars on top and the left side.

2) **Create an account and get access (figure 2):**

- Click on the “special pages” tab in the left navigation bar and look for “create account” (under “Login/Create Account”).
- Choose a username and a password and confirm your email address.
- Click on the “Create account” button
- Change your password after receiving the invitation mail

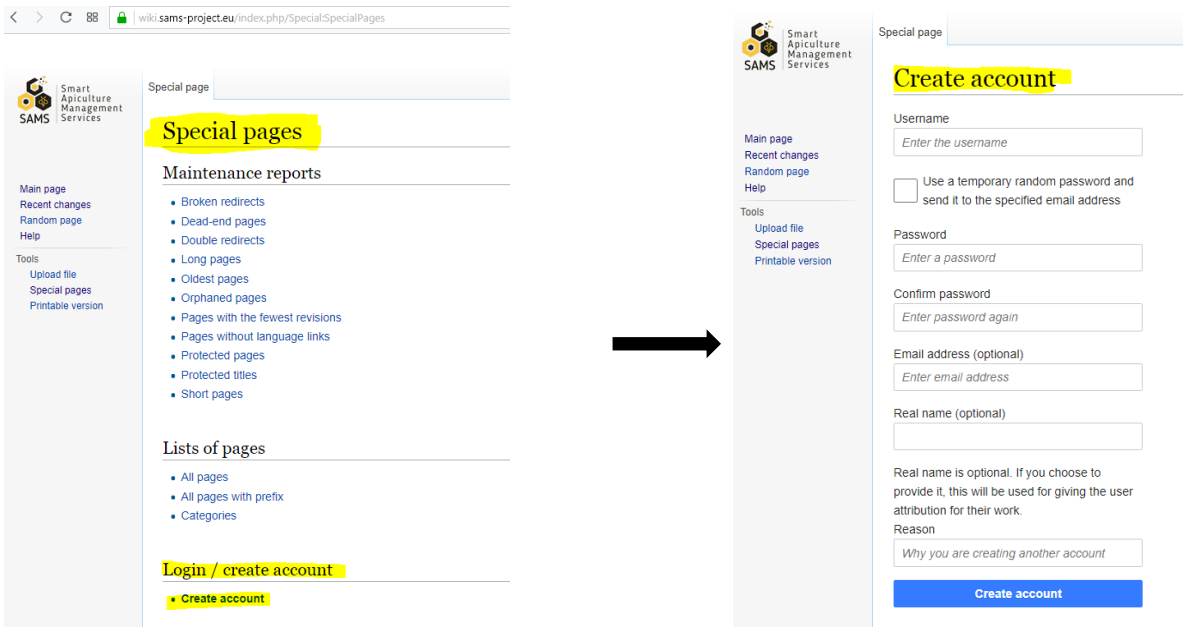

Figure 2: Through “special pages” and by choosing a username and a password it is possible to create an account

3) Edit an existing page (figure 3):

- Click the "Edit" page tab at the top of the page.
- Make changes to the text.
- Click the "Save page" button.

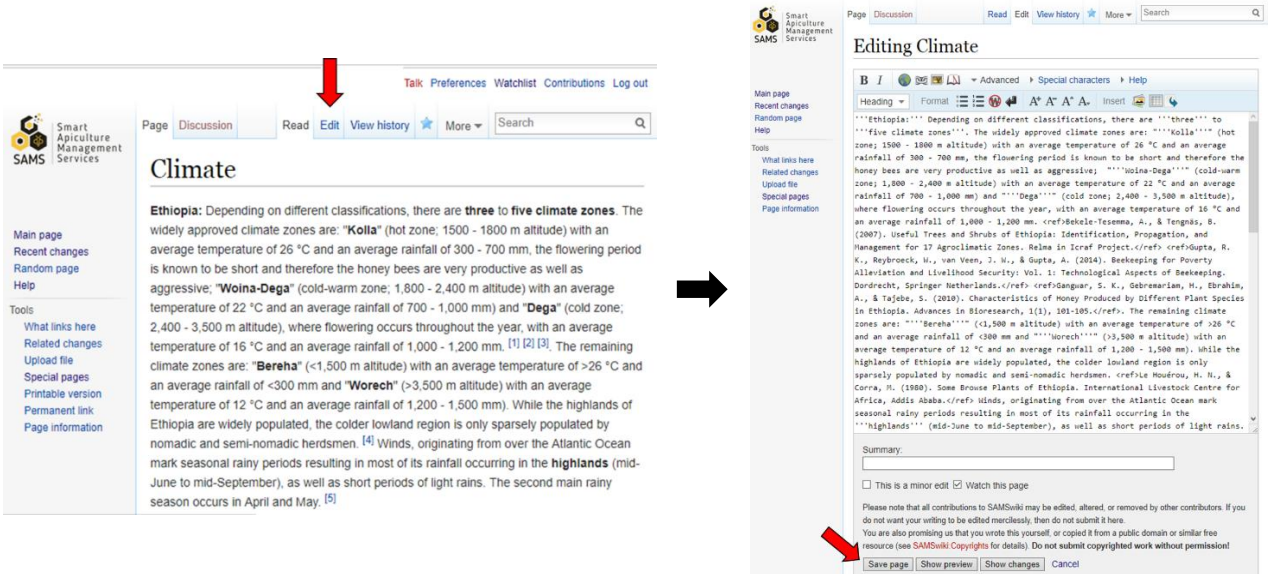

Figure 3: Use the “edit” tab and the “safe page” button to edit an existing page

4) Create a new page (figure 4):

- If you search for a page that does not exist (using the search box and "Go" button on the left of the page) then you will be provided with a link to create the new page.
- Click on the red coloured name of the new page (in the example given in the picture below: “Ethiopia”)
- Write your text
- Click on the “Safe page” button given on the end of the page (same as in “edit an existing page”)

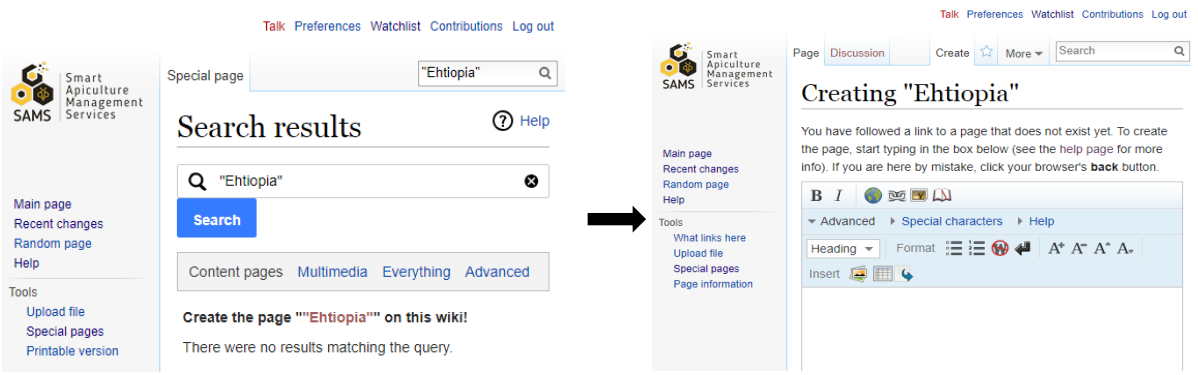

Figure 4: Use the search box to create a new page.

5) **For further information (how to use html style, how to embed pictures, or tables, …) use the following link: https://www.mediawiki.org/wiki/Help:Contents**

6) **Citation style**

The information provided in the SAMSwiki is based on scientific literature and on expert interviews. For this reason, always provide references to new content. To guarantee a uniform style of the SAMSwiki pages, use the following citation style: **APA TAYLOR AND FRANCIS.**

An instruction on the mentioned citation style is given under the URL (access date: 11.12.2018): https://www.tandf.co.uk/journals/authors/style/reference/tf_APA.pdf

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