# International Partnership on Innovation

# SAMS - Smart Apiculture Management Services

Deliverable N° 4.5

## Capacity Building for the Implementation and Application of the DSS – Achievements and Lessons Learnt

N° 4 – Decision Support System

Horizon 2020 (H2020-ICT-39-2017)

Project N°780755

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## SAMS consortium partners

| Logo | Partner name | Short | Country |
|---|---|---|---|
| giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH | Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (Coordinator) | GIZ | Germany |
| UNIKASSEL VERSITÄT | University of Kassel | UNIKAS | Germany |
| KARL-FRANZENS-UNIVERSITÄT GRAZ UNIVERSITY OF GRAZ UNI GRAZ | University of Graz (Institute for Biology) | UNIGRA | Austria |
| Latvia University of Life Sciences and Technologies | Latvia University of Life Sciences and Technologies | UNILV | Latvia |
| iceaddis | ICEADDIS – IT-Consultancy PLC | ICEADDIS | Ethiopia |
| IQQO Oromia Agricultural Research Institute | Oromia Agricultural Research Institute, Holeta Bee Research Center | HOLETA | Ethiopia |
| Universitas Padjadjaran | University Padjadjaran | UNPAD | Indonesia |
| PRIMARY TRAINING & CONSULTING | Commanditaire Vennootschap (CV.) Primary Indonesia | CV.PI | Indonesia |

## List of Abbreviations

| | |
|---|---|
| CB | Capacity Building |
| DSS | Decision Support System |
| DW | Data Warehouse |
| ET | Ethiopia |
| EU | European Union |
| ICT | Information and Communications Technology |
| ID | Indonesia |
| PS | Partnership |
| T | Training |
| TT | Training of Trainers |
| UCD | User Centered Design |
| UI | User Interface |
| WS | Workshop |

## 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

As part of the User Centred Design cycles and of the SAMS project and to ensure long-term impact and dissemination of the SAMS HIVE monitoring system, and modern beekeeping techniques, a capacity building (CB) program for the decision support system (DSS) implementation and application was conducted. CB on DSS implementation and application was quite basic as the DSS relies on collected data to be functional. It becomes clear that the DSS is strongly linked to the SAMS Data Warehouse and the related SAMS hive systems. As the SAMS system faced problems in collecting and transferring real-time data from Ethiopia and Indonesia to Europe the development of the DSS was hindered and could not be completely finalized as the country-specific infrastructure and other technical aspects had a major impact on real-time continuous monitoring, therefore SAMS mostly worked with/ provides historical data, which lead to the fact that a final DSS could not be implemented and therefore no real trainings on the use of DSS were done.

Nevertheless, related trainings were conducted. The program was one of three CB programs conducted during the SAMS project time and beyond in the SAMS target regions Ethiopia, Indonesia and Europe. The three CB Programs were focused on the following to main activities:

- conduction of workshops and trainings which aimed to building of capacity through theoretical and practical training, and
- establishment of partnership-networks for long-term CB after SAMS project end.

Activities and trainings within the CB Program on DSS implementation and application were conducted in English language as well as in the local languages Amharic and Bahasa. The main target group of the trainings were beekeepers, software developers and future SAMS business developers. Main achievements of the trainings conducted in Ethiopia, Indonesia and Europe were:

- **Ethiopia**: conduction of 10 trainings for 293 participants from different regions in Ethiopia including Beekeepers, researchers, and other beekeeping experts. Trainings were conducted in Amharic and English.
- **Indonesia**: conduction of 2 trainings for 9 participants including beekeepers and internal SAMS-staff. All trainings were conducted in Bahasa.
- **Europe**: Conduction of 8 training for 65 participants. The trainings were conducted in English and German.

As part of the UCD cycles of the SAMS project, all results of the CB activities and feedback provided by participants from CB activities were carefully monitored. This served for user-centred optimization of the SAMS system and adaptation of the CB program. Main learnings of the training include:

- LL for the optimization of the SAMS hive system
- LL on the value of SAMS for the DSS for the participants / SAMS users and the related SAMS Data Warehouse
- LL for the conduction of further trainings and on provided learning materials

# 1. The capacity building program on DSS implementation and application

The capacity building (CB) program on Decision Support System (DSS) implementation and application was one of three CB programs conducted during the SAMS project time. Achievements and lessons learnt of additional CB activities are reported in the deliverables *D3.7 Capacity Building on Modern Beehive Construction – Achievements and Lessons Learnt* and *D5.4 Capacity Building on Bee-Management and Bee-Health – Achievements and Lessons Learnt*.

## 1.1 Aim of the capacity building program

The main aim of the capacity building Program was to build capacity and increase skills for the implementation and application of appropriate DSS. It further aims to adapt knowledge for similar systems and to foster optimization of the DSS (in compliance with the User Centered Design (UCD) principles for different regional settings). Therefore, the training also served to gain better understanding of the user needs and related requirements for the SAMS system. The SAMS team thus used the training to collect feedback on the SAMS idea and prototype and adopt it accordingly.

In the long-term, the CB program aimed to strengthen local entrepreneurships within SAMS and to foster intense cooperation within the three established SAMS partnerships beyond project running time. These partnership networks should further gain access to information and training material.

Main target groups for the trainings were existing and potential beekeepers (end-users), software developers and future SAMS business developers. Moreover, the training aimed at fostering female participation in the training in order to meet the overall European Target of engaging female actors[1]. The program should enable them to gain an in-depth understanding

- on the adaptation, implementation and application of the EU based DSS for local needs in Indonesia and Ethiopia, and
- on the application of the HIVE monitoring system.

## 1.2 Analysis of local requirements

To ensure the maximum impact of the CB program, an analysis of the modern beekeeping and related challenges related to implementation and adaptation of the DSS in the target regions Ethiopia and Indonesia, was conducted. The analysis served to gain better understanding of requirements and needs of the target group and to define the strategy, content and applied methodologies for specific CB activities. Furthermore, the target groups and the term Decision

[1] Fact sheet: Gender Equality in Horizon 2020 (Dec. 9th, 2013), URL: h2020-grant-factsheet_en.pdf (europa.eu)

Support System were defined in order to find common ground for the implementation of the activities.

### 1.2.1 Description of the Decision Support System

Overall, the Decision Support System (DSS) can be considered as a system that assists users in any kind of decision-making process. As the DSS can be used in various contexts and problem areas, there is no single definition of the DSS which includes all aspects. The architecture of the DSS consists of several aspects, including data management system, model management system, knowledge base, user interface (UI) and usability. Consideration of these aspects during the development of the DSS is important for its proper operation and adaptation to the context in which it will be used and to the needs and requirements of its end-users. Therefore, it is important for software engineers to understand the system´s end-users and the local context and manner in which the DSS will be used - from data collection (how to accept and store incoming data, what will be stored etc.) to data output for the beekeeper. Since the UI of a DSS is the bridge between end-user and the system that processes and analysis data based on knowledge, the UI plays an important part and ensures that the end-user will get the most benefit out of the DSS. By doing so, the DSS can be used to its full potential.

In the case of the SAMS DSS, the end-users are beekeepers and future SAMS business developers. The CB program on DSS implementation and application was a key tool to gain better understanding of the end-users of SAMS, to learn from them and to build their capacity in using the DSS. More information on the SAMS DSS can be found in the SAMSwiki and in report D4.4 Concept of the Decision Support System. Access to the SAMS Data Warehouse can be found online.

### 1.2.1 Analysis of the implementation of DSS in Ethiopia and Indonesia

An analysis of bee colony monitoring systems and DSS in the target regions Ethiopia and Indonesia led to the following main findings. More information on beekeeping can be found in D3.1 Manual on Beehive Construction and Operation, D5.1 Bee-Management and Bee-Health Indicators and the SAMSwiki.

Table 1 Main beekeeping-related and DSS-related challenges in Ethiopia and Indonesia

| Ethiopia | Indonesia |
|---|---|
| • Beekeeping has a long tradition<br>• Different types of hives (traditional, transitional and modern) are used by beekeepers<br>• Traditional and transitional beehives are not suitable for using a beehive monitoring system | • The beekeeping ecosystem is not as developed as in Ethiopia and Europe.<br>• Immaturity of the ecosystem resulting in a lack of integrated support from beekeeping stakeholders.<br>• Beekeepers are avid users of smartphones, so web-based decision support systems are less popular. |

| | |
|---|---|
| • Beekeepers are eager to use SAMS beehive monitoring system but complain about the problem of availability in the country<br>• The SAMS DSS is the first IT based hive monitoring system with support function<br>• Beekeepers, particularly youth groups, prefer to use smartphones and hence mobile phones are preferred for DSS<br>• Ethiopian bees are aggressive and any reliable remote sensor-based advice is the most welcome | • Beekeepers are heavy users of smartphones but not email, for account set up in the DSS account, phone numbers are preferable.<br>• Beekeepers have their way of beekeeping and value personal relationships highly. This made it hard for them to trust the advice from some system that has no face or personality. |

### Ethiopia

In Ethiopia, beekeeping has a long tradition and different types of hives are used by beekeepers, including traditional, transitional and modern beehives. Nevertheless, the SAMS monitoring system is the first IT based beehive monitoring system in Ethiopia. There are no beehive monitoring system builders and the technology is still new to the beekeepers. Still, many beekeepers in Ethiopia seem to be interested in the technology and see the potential and benefits it may bring to their work.

Based on these observations, the CB program in Ethiopia focused on building capacity of beekeepers and future SAMS business developers in basic understanding the functionality and value of the DSS for their work.

### Indonesia

In Indonesia, there was neither any system available to monitor bee health before the SAMS project nor any standard for modern beehive. The SAMS project pioneered the idea of an IT monitoring system for bees in Ethiopia and disseminated the idea within the country. In the long run, this might trigger the necessity for IT monitoring system manufacturers and development of DSS by software developers. Nevertheless, beekeepers in Indonesia are still doubtful of the necessity and usability of a Decision Support System for their beekeeping activities. They value personal relationships highly and have little trust in working with a machine.

As the modern beekeeping ecosystem in Indonesia is not yet that developed, the CB program in Indonesia focused on building capacity of the target group in basic understanding of the functionality and value of the DSS for their work.

## 1.2.1 Definition and analysis of the target group

Based on the above analysis, the target groups of the CB program and their main challenges of the target group concerning the implementation of and application of the DSS were defined as follows.

## Beekeepers (end-users)

*Beekeepers* were defined as established beekeepers (including new and "master" beekeepers), well as potential beekeepers who are interested in starting a beekeeping business. Start-ups and students were considered as potential future beekeepers.

**Ethiopia**: To beekeepers in Ethiopia the DSS technology is still new. They were never in contact with ICT monitoring of beehives and have no knowhow on working with Decision Support Systems for the management of their beehives, which leads also to the fact that gender consideration is not done in this field. Main challenges of this target group concerning the implementation and application of the DSS are:

- Lack of adequate material
- Lack of experience knowledge in the field to easily understand the concept

**Indonesia**: Beekeepers in Indonesia usually conduct beekeeping activities manually. No digital technology has been practiced before the SAMS project. Moreover, the beekeeping "profession" is still dominated by male actors, while female actors (wife and daughters) usually play a non-professional supporting role in the beekeeping business. Beekeeping is still perceived as a masculine profession mainly because bees have a dangerous stigma. Main challenges of this target group concerning the implementation and application of the DSS are:

- Beekeepers have their way of beekeeping and value personal relationships highly, made it hard for them to trust the advice from some system that has no face or personalities.

## Software developers

Software developers were defined as developers of DSS software. In a broader sense also IT students were counted as potential software developers.

**Ethiopia**: Software developers in Ethiopia are only few in numbers, which leads to the fact that not many women are active in this field yet as it is mainly male dominated. Main CB challenges for the implementation and application of the DSS for this target group are:

- Lack of knowledge in adaption of the concept
- No readily available example DSS during the training and only theoretical concept

**Indonesia**: Software developers in Indonesia are abundant, but the beekeeping ecosystem in Indonesia is not yet that developed. Therefore, only a few software developers put interest in developing systems for beekeepers. Therefore, the introduction of software developers in Indonesia to the DSS was not seen as useful, and CB was not conducted for this target group.

## Future SAMS business developers

Future SAMS business developers were defined as beekeepers, beekeeping experts, and ICT start-ups, ICT consultants and service providers.

**Ethiopia**: In Ethiopia, a variety of different stakeholders were identified as future SAMS business developers and invited to the trainings. These include ICT start-ups, ICT consultants and service providers. Main CB challenges the implementation and application of the DSS for this target group are:

- Lack of knowledge in the adaptation of the DSS
- Lack of technical knowledge background

**Indonesia**: In Indonesia, future SAMS business developers were defined as ICT start-ups and ICT consultants and service providers. Nevertheless, capacity building for future SAMS business developers is not conducted in Indonesia.

## 1.3 Strategy for the conduction of the CB program

In order to achieve the above-mentioned aims, a CB strategy was developed by GIZ and discussed, reviewed and accepted by the SAMS consortium partners in the target regions Indonesia, Ethiopia and the EU. The program consisted of two main activities:

- conduction of workshops and trainings which aimed to building of capacity through theoretical and practical training, and
- establishment of partnership-networks for long-term CB after SAMS project end.

All results of the CB activities and feedback provided by participants from CB activities were carefully monitored for user-centred optimization of the SAMS system and adaptation of the CB program. Although activities were also conducted in Europe, Ethiopia and Indonesia were in focus regions of the CB program.

### 1.3.1 Capacity building through workshops and trainings

The implementation of workshops and training for CB on the DSS was primarily focused on the target regions of Indonesia, Ethiopia. Nevertheless, one training was also conducted in the EU. The program started with the first pilot implementation in March 2019 in Indonesia, April 2019 in Ethiopia, and ended in December 2020. Main responsible partners for the implementation were HOLETA (Ethiopia) and CV.PI (Indonesia) and UNILV (EU).

#### Topics

Based on the analysis of local stakeholders and markets, overarching key questions were defined for CB workshops and trainings:

Table 2: Topics of the CB Program on DSS Implementation and Application in Ethiopia, Indonesia and Europe

| Leading question | Ethiopia | Indonesia | Europe |
|---|---|---|---|
| How to implement the HIVE Monitoring System? (important for beekeepers) | Yes | Yes | Yes |

| | | | |
|---|---|---|---|
| How to adapt the DSS for local needs? | Yes | Yes | |
| What are the problems/ risks of the Hive monitoring system/ DSS in general? | Yes | Yes | Yes |
| What are the local problems/ risks of the Hive monitoring system and the DSS? | Yes | Yes | |

## Participants

In addition to the main target groups of the program (beekeepers (end-users), software developers and future SAMS business developers), further stakeholders were invited to the CB trainings. These stakeholders included IT students, beekeeping experts, and researchers. This served to create awareness and to disseminate knowledge amongst a greater range of stakeholders. Moreover, it was considered that the inclusion of such stakeholders will provide more feedback from a greater variety of stakeholders. Another factor was, that particularly start-ups and students were considered as potential future beekeepers, thus adding to the goal to creating interest in new beekeeping technologies and awareness of their benefits amongst younger generations and future SAMS business developers. Moreover, the CB activities were widely disseminated in order to attract female participants.

In addition, trainings for trainers were conducted for staff of the SAMS. This was to ensure that SAMS staff is well-trained in the implementation and application of the DSS in order to foster the dissemination of the knowhow through future CB trainings and activities within the SAMS partnerships.

## Types of training and applied methodologies

The aim of the trainings consisted of theoretical and practical transfer of knowledge and expertise on the implementation and application of the DSS. In order to achieve this, different types of training were developed within the CB program:

- **Trainings for trainers**: aimed to ensure long-term impact of the CB programme by training future trainers for modern beehive and SAMS beehive construction
- **Workshops with Beekeepers**: aimed to build capacity and promoting the utilization of modern beehive amongst beekeepers (the end-users of beehives) and to create awareness on the benefits of the DSS. Beekeepers also counted as potential SAMS business developers
- **Workshops with bee experts and researchers**: aimed to build capacity and promote the utilization of the DSS amongst additional potential users of modern beehives. They further aimed at ensuring long-term impact of the CB program by involving leading regional experts in the field of beekeeping and learning from them for the optimization of the DSS (e.g. adjustments to the knowledge base, which is the “brain” for the DSS).
- **Workshops with IT students and software developers:** aimed at building capacity in the use and development of the DSS and to introduce IT-stakeholders to the topic of precision beekeeping. It further aimed to gain insights for the optimization of the DSS.

- **Video recordings**: aimed at informing about the SAMS DSS and on data analysis for beekeepers. Two videos were developed and published, as well as shown during the SAMS Final Conference and during the 4th International Hive and Monitoring Conference – they can be seen online: The SAMS Data Warehouse and Honey Bee Colony State Detection by Temperature Data

### Practical training in implementation and application of the DSS

It was planned to conduct different types of practical training for implementation and application of the DSS:

- Construction, configuration and testing of the SAMS HIVE system prototype based on Raspberry Pi (Europe)
- SAMS Data Warehouse configuration and testing for data transfer and display (Europe)
- Training in the use of and testing of the DSS User Interface (UI) (Ethiopia and Indonesia)

### Training materials

All trainings are supported by a variety of learning materials. The language of the materials (English or local languages) was chosen by the implementing trainers, depending on the requirements of the training participants. Long-term availability of the materials to training participants and to the SAMS partnership networks is ensured through publication on the SAMS website and SAMSwiki after conduction of the training.

## 1.3.2 Long-term capacity building through SAMS partnerships

In addition to the training program, long-term partnerships between the SAMS partners were established within the three international SAMS partnerships:

- SAMS business development (PS1),
- bee colony data and knowledge exchange (PS2) and
- apiculture technology and services (PS3).

These growing partnership networks between the SAMS beneficiaries and national and international stakeholders of the beekeeping sector and scientific society, aim to work together for the purpose of long-term dissemination of the SAMS project results and mainstreaming of the SAMS HIVE system. Learn more about the partnerships here. This chapter summarizes the activities conducted between 2018 and 2020 within the capacity building program on DSS implementation and application. It summarizes the achievements of each activity, as well as lessons learnt from observations and participants feedback.

# 2. Conducted Capacity Building Activities

This chapter summarizes the activities conducted between 2018 and 2020 within the Capacity Building Program on DSS Implementation and Application. It summarizes the achievements of each activity, as well as lessons learnt from observations and participants feedback.

## 2.1 Activities conducted in Ethiopia

In Ethiopia, 10 trainings and workshops were conducted for 293 participants from research, development and ICT sectors.

Table 3 Activities conducted in Ethiopia

| Date | CB activity | Target group | Location | Duration | Participants | Language | Partner |
|---|---|---|---|---|---|---|---|
| April 24th -28th, 2019 | Workshop on seasonal colony management, bee-health and the DSS (No. 1) | Beekeepers from Wodesa PA and beekeeping experts | Ambo | 40 hours (5 days) | 34 participants (5 female) | English | HOLETA |
| May 22nd – 26th, 2019 | Workshop on seasonal colony management, bee-health and the DSS (No. 2) | Beekeepers from different sites of Wolmera districs | Holeta Research Centre, Holeta | 40 hours (5 days) | 40 participants (36 female) | Amharic | HOLETA |
| June 17th- 21st, 2019 | Workshop on seasonal colony management, bee-health and the DSS (No. 3) | Beekeepers from Dendi District, Ejersa Lefo PA | Ginchi | 40 hours (5 days) | 31 participants (9 female) | Amharic | HOLETA |
| August 2nd 2019 | Workshop adaption of beehive monitoring Systems | Capacity building Workshop with IT companies, IT start-ups and involving researchers | Holeta Bee Research Center | 5 hours (1 day) | 7 participants (all male) | English | HOLETA |
| January 18th, 2020 | Workshop on SAMS Beehive prototyping, including DSS | Researchers (Ethiopia-wide centres) | Holeta Research Centre, Holeta | 3 hours (1 day) | 33 participants (4 female) | English | HOLETA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | software and awareness creation (No. 1) | | | | | | |
| January 22nd-23rd, 2020 | Workshop on seasonal colony management, bee-health and the DSS | Beekeepers from Guduru and Hababo Guduru Districts and beekeeping facilitators | Guduru, Kombolcha | 15 hours (2 days) | 40 participants (38 female) | Amharic | HOLETA |
| February 6th, 2020 | Workshop on SAMS Beehive prototyping, including DSS software and awareness creation (No. 2) | Beekeeping experts | Holeta Research Centre, Holeta | 3 hours (1 day) | 33 participants (2 female) | English | HOLETA |
| June 12th – 13th, 2020 | Workshop on seasonal colony management, bee-health and the DSS | Beekeepers from Borodo Water shade area; Dandi beekeeping district experts | Ginchi, Borod | 15 hours (2 days) | 31 participants (9 female) | Amharic | HOLETA |
| August 29th – 31st, 2020 | Workshop on seasonal colony management, bee-health and the DSS | Beekeepers from Wolmera district | Holeta Research Centre, Holeta | 15 hours (3 days) | 40 participants (36 female) | Amharic | HOLETA |
| Jun 1 – Jun 2 2020 | DSS Interface usability test | Beekeeper from Holeta | Holeta Research Centre, Holeta | 4 Hours (2 Days) | 4 participants | Amharic | iceaddis |

### 2.1.1 Workshops on seasonal bee colony management, bee-health and the DSS (5-day-workshop)

Between April and June 2019, three 5-day workshops on seasonal bee-colony management and bee-health were conducted in different locations across Ethiopia. The trainings aimed at building capacity and providing in-depth knowledge on beekeeping equipment and its usage, with special focus on seasonal specifications and the establishment of colony management plans, as well as on the DSS. Participants were beekeepers and beekeeping experts from Wolmera and Dendi districts. Most of them had traditional beekeeping knowledge but lacked knowledge on modern beekeeping.

#### Achievements

Theoretical and practical training of 105 beekeepers and beekeeping experts, of which 50 were female, from different locations across Ethiopia:

- Day 1: Introduction to SAMS, honeybee colony monitoring methods including ASS and DSS, and introduction to the new beehives system
- Day 2-5: Building capacity on seasonal colony management techniques, knowledge transfer on product diversifications, on bee-health and bee-health related problems, and identification of bee diseases, pests, predators and agrochemicals. For more information see also D5.4 Capacity Building on Bee-Management and Bee-health – Achievements and Lessons Learnt

Successful awareness creation on the SAMS beehive monitoring system and DSS and its usability for future beekeeping. In addition, awareness was successfully created for the importance of marketing their products. The usage of improved technology was accepted as useful by the beekeepers. After the training, many participants were eager to own transitional hives and modern beehives by the end of the year.

Many participants were interested in joining the International Partnership on SAMS Business Development (PS1) and many were identified as potential SAMS business partners.

#### Lessons Learnt

**LL for the conduction of further trainings and on provided learning materials**

- Recommendation by the beekeepers to get training that is more practical on bee management particularly on how to identify weak, medium and strong colonies

### 2.1.2 Workshops on seasonal bee colony management, bee-health and the DSS (2 - 3-day workshop)

In January, June and August 2020, two 2-day workshops and one 1-day workshop on seasonal bee colony management, bee-health and the DSS were conducted. The trainings focused on gaps in technical expertise of beekeepers which were previously identified during a training

conducted in June 2019 at beekeepers´ apiaries, as well as on the DSS. Participants were beekeepers and facilitators with knowledge gaps on bee management and bee health.

## Achievements

Theoretical and practical training of 111 beekeepers and beekeeping facilitators (of which 83 were female):

- Day 1: Build capacity for the improvement of beekeeping management techniques and bee colony productivity: introduction to honeybee colony monitoring methods, new beehive system and demonstrating the prototype, the SAMS monitoring system ASS and DSS
- Day 2-3: Building capacity on active and seasonal colony management (Identification of seasons, harvesting honey and processing, post-harvest management of bee products). For more information see also D5.4 Capacity Building on Bee-Management and Bee-health – Achievements and Lessons Learnt

Successful awareness creation on the SAMS HIVE monitoring system development and on the usability of DSS for future beekeeping. Participants were convinced to use the SAMS HIVE systems and change their beekeeping practice from traditional to modern in the future. Many participants believed that if they have the chance to receive another CB training, it would completely change their understanding about modern beehive and the SAMS HIVE monitoring system.

An additional aim of the training was to create employment opportunities for participating beekeepers (particularly for women) by helping their involvement in SAMS business and in different marketing networks. Therefore, many participants were introduced to the SAMS partnerships and expressed interest to join the International Partnership on SAMS Business Development.

## Lessons Learnt

**LL concerning bee-management and bee-health influencing the DSS**

- A major problem for most beekeepers is the lack of knowledge on the floral calendar and on how to manage colonies during the active and dearth seasons – seasonal management
- Almost every beekeeper lacks knowledge on how to place beehives in the apiary
- Production and productivity of beekeeping in the area is found to be very low as practical skills on colony management and bee health are lacking and low frequency of honey harvesting (only once out of possible three times)
- Most beekeepers use traditional or transitional beehives

**LL for the conduction of further trainings and on provided learning materials**

- Participants requested more practical training on how to utilize the modern beehive in the field to enable themselves to benefit of the DSS and possible related action for seasonal management

Figure 1: Field visit to a model apiary in Yero Amatole

### 2.1.3 Workshop on SAMS beehive prototyping, including DSS software and awareness creation

In January and February 2020, two trainings on beehive prototyping and awareness creation were conducted. Knowledge transfer on the SAMS prototype components, its hard- and software and precision beekeeping, as well as practical field experience with the SAMS monitoring system. Participants were researchers form different research centres located in different regional states of Ethiopia and four beekeeping experts from Oromia National Regional State of Ethiopia.

#### Achievements

Training of 33 researchers (from which 4 were female) and 33 beekeeping experts (from which 2 were female) from different regions across Oromia and Ethiopia:

- Knowledge transfer on the SAMS prototype components and on the hardware and software solutions developed within the SAMS project
- Practical field experience with the SAMS monitoring system and bee colony monitoring methods
- Knowledge transfer on precision beekeeping, bee colony monitoring and usefulness of the SAMS system for research purposes

Successful awareness creation on the SAMS system and development of wide-spread interest in different regions amongst researchers and beekeeping experts across Ethiopia.

#### Lessons Learnt

**LL on the value of SAMS and the DSS for the participants/ SAMS users**

- Researchers and experts understood the benefits of SAMS system but are not able to use such system on their own also considering recommendations by the DSS

**LL for the conduction of further trainings and on provided learning materials**

- Need for additional CB with the same participants for more practical, hands-on training

### 2.1.1 Workshop on DSS user testing

The user interface plays an important role in the whole system. Without a properly designed UI, user cannot use the system to its full potential. Therefore, a UI for DSS mobile application was designed by considering user needs and feedback during the development process. According usability tests were conducted four Ethiopian beekeepers (end-users). Based on feedback the interface prototype was refined accordingly.

#### Achievements

- Test shows that such a development process must be done in every single context and for every single considered user/ stakeholder group as the feedback showed, that expectations and requirements differ
- Refinements of the Ethiopian DSS SAMS data display for beekeepers according to the usability tests

#### Lessons Learnt

**LL for the SAMS DSS Interface**

- The interaction flow of the on-boarding and login to an account page was adopted – it was simplified because the first on-boarding page design was rated unintuitive by the testing beekeepers.
- Change of the UI/ UX terms to commonly known and detail expressions beekeeping terminology because the mixed standard UI/ UX terms with common beekeeping management keywords were not clear for the beekeepers
- Remove of the QR code function from the design because the QR code scanning function was not a familiar technique to the beekeepers and interrupts to the hive registration flow
- Inclusion of hive transfer option as the beekeepers want to have hive tracking feature for hive setup locations to move hives to a different location

**LL for SAMS business development**

- The user interface prototype is available open source for further elaboration and for developing an app to facilitate a business
- It must be ensured that the app repeats its usability test to ensure the use of such app and that users are able to understand different possibilities

## 2.2 Activities conducted in Indonesia

In Indonesia, 2 trainings were conducted for 9 participants from Beekeepers and internal SAMS team.

Table 4 Activities conducted in Indonesia

| Date | CB activity | Target group | Location | Hours | Participants | Language | Partner |
|---|---|---|---|---|---|---|---|
| June 16th – 20th, 2020 | Workshop on DSS user testing and local contextualization | Beekeepers | Bogor, Bandung, Ciamis | 10 hours (5 days) | 5 participants (0 female) | Bahasa | CV.PI |
| September 10th 2020 | Co-creation workshop on DSS flow adaptation | Internal SAMS team | Bandung | 4 hours | 4 participants (2 female) | Bahasa | CV.PI |

### 2.2.1 Workshop on DSS user testing and local conntextualization

The user interface plays an important role in the whole SAMS hive and DSS system. Without a properly designed UI, user cannot use the system to its full potential. Therefore, a UI for DSS mobile application was designed by considering user needs and feedback during the development process. From June 16 -20, 2020, a training on DSS user testing and local contextualization was conducted as virtual training with the LookBack application. The virtual format was chosen because of restrictions due to the Covid-19 pandemic. Participants were grassroot beekeepers located in five different locations throughout West Java; Bogor, Bandung, and Ciamis. Based on feedback the interface prototype was refined accordingly.

#### Achievements

Local contextualization on the DSS interface and testing on 5 beekeepers:

- Feedback on the DSS interface according to local beekeepers needs
- Improvements ideas and insights for the development of the DSS Interface
- Beekeepers promote and support the data visualization in the DSS interface

#### Lessons Learnt

**LL for the SAMS DSS Interface**

- Simplifying information on the onboarding page
- Simplifying the registration/assigning hives and monitoring system process
- Beekeepers prefer phone numbers instead of emails to create an account
- Notification on troubled hives need to be more prominent

**LL for SAMS business development**

- Service design for pre set-up monitoring system purchased/owned by beekeeper might be needed
- It must be ensured that the app repeats its usability test to ensure the use of such app and that users are able to understand different possibilities

**LL on bee-management and bee health**

- Local beekeeping knowledge need to be considered when suggesting the solution of danger hive's condition

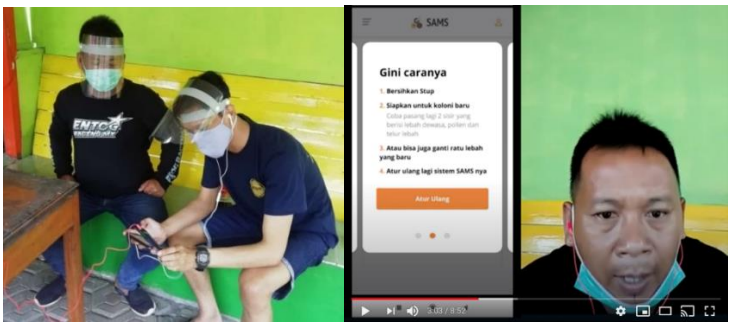


Figure 2: The usability testing process with the beekeepers

### 2.2.2 Co-Creation workshop of DSS flow adaptation

On September 10th, 2020, a co-creation workshop on DSS flow adaptation was held for the CV.PI internal SAMS team. This activity highlighted the feedback from beekeepers who tested the DSS interface beforehand and aimed at brainstorming and co-creating the proposed solution for iteration of the DSS interface. Participants were SAMS internal team members from CV. PI.

#### Achievements

Co-creation on the next iteration of the DSS user interface between 4 members:

- Taking beekeepers' feedback on the previous DSS UI, the participants were able to identify any confusing or unnecessary steps to create a seamless process
- New flow on the DSS user interface for the beekeepers was created
- New ideas on the pre-set-up design services were proposed

#### Lesson Learned

**LL for SAMS business development**

- Service design to fulfil customer needs is essential to be developed further
- There's opportunity in other field of business for SAMS monitoring system

Figure 3: Co-creation process with the staff from CVPI

## 2.3 Activities conducted in Europe

In Europe CB for the SAMS hive system and the SAMS DW as well as DSS connection were conducted together. Overall 8 training were conducted for 65 participants from Latvia and Germany. During the training measurement systems were constructed and connected to the SAMS DW for data transfer.

Table 5: Activities conducted in Europe

| Date | CB activity | Target group | Location | Duration | Part |
|---|---|---|---|---|---|
| January 1st, 2019 | Lecture Digitalization in agriculture (SAMS) | Students | University of Kassel, GER | 2 hours | 7 parti (4 fem |
| Mai 13th, 2019 | Training for Students | Students | University of Kassel, GER | 2 hours | 4 parti (1 fem |
| November 15th, 2019 | SAMS hardware system development | IT Students | Latvia University of Life Sciences and Technologies | 8hours (1 day) | 23 par (4 fem |
| November 25th, 2019 | Training for Students | Students | University of Kassel, GER | 2 hours | 5 parti (2 fem |
| February 10th, 2020 | Training for Students | Students | University of Kassel, GER | 2 hours | 3 parti (0 fem |
| May 27th, 2020 | Training for Students | Students | University of Kassel, GER | 2 hours | 6 parti (2 fem |
| August 10th, 2020 | Training for Students | Students | University of Kassel, GER | 2 hours | 4 parti (0 fem |
| December 9th, 2020 | Lecture Digitalisation in agriculture: Precision beekeeping (SAMS) | Students | University of Kassel, GER | 3 hours | 13 par (6 fem |

### 2.3.1 Training on SAMS hardware sytem development

The training was conducted at Latvia University of Life Sciences and Technologies IT with students from the Faculty of Information Technologies and Erasmus students. The objective of the workshop was to introduce the SAMS project to the IT students, demonstrate different hardware and software solutions developed within the project and to give hands-on exercises on SAMS hardware development and connection to the SAMS Data Warehouse.

#### Achievements

The practical and theoretical training of 23 IT students allowed the participants to gain experience in system debugging, to identify errors in hardware and software side, as it is an integral part in every system's design and development process. This also allowed to evaluate what should be changed/ improved to better detect and back trace possible errors during SAMS system setup:

- Knowledge transfer on the SAMS project, precision beekeeping, bee colony monitoring and the SAMS hardware
- Knowledge transfer on the SAMS DW its specifics (authentication and authorization, objects and their mapping, logical structure and hierarchy etc.) and enabling participants to connect their prototypes to the DW using specific credential file and authorisation procedure
- Practical exercise for the installation of SAMS Raspberry Pi image and connection of Raspberry Pi to the wireless network
- Assembling of the prototype for the SAMS monitoring system: based on provided schematic and instructions, participants connected different sensors to the breadboard
- When prototypes were successfully connected, participants calibrated the scales and made several test measurements
- Introduction to Witty Pi for the Raspberry Pi power management and practical exercise to connect those two devices and test the power management options (schedule power on/ off times)

## Lessons Learnt

**LL for further development of SAMS**

- The configuration of additional devices involved, such as Wi-Fi router, should also be considered: there were some issues with a network DNS (Domain Name Server) therefore additional router configuration was needed to grant the access to the SAMS DW
- The human factor is very important to develop working prototypes: it is needed to be very attentive while wiring the sensors and writing the code, as any mistake can cause system instability and even stop the operation

**LL for the conduction of further trainings and on provided learning materials**

- Based on the feedback it is suggested to decrease the time for the workshop and split it to two days, because for this target group it was difficult to be concentrated for the whole day

Figure 4: Testing and applying the System

### 2.3.2 Training for students – SAMS HIVE system implementation and its connection to the SAMS Data Warehouse and DSS

In the respective training sessions, which were conducted by the University of Kassel at the test site and seminar room of the apiary in Witzenhausen, the students were taught the essential project contents and the construction and operation of the SAMS HIVE systems.

#### Achievements

Practical and theoretical training of students:

- The training allowed the participants to gain experience in system debugging to identify errors in hardware and software, as an integral part in every system's design and development process. This allowed to evaluate what should be changed/ improved to better detect and back trace possible errors during SAMS system setup
- Knowledge transfer on the SAMS project, precision beekeeping, bee colony monitoring and the SAMS hardware
- Knowledge transfer on the SAMS DW as part of the overall SAMS system
- Practical exercise for the installation of SAMS Raspberry Pi image and connection of Raspberry Pi to the wireless network
- Assembling of the prototype for the SAMS monitoring system: based on provided schematic and instructions, participants connected different sensors to the breadboard
- When prototypes were successfully connected, participants calibrated the scales and made several test measurements. Introduction to Witty Pi for the Raspberry Pi power management and practical exercise to connect those two devices and test the power management options (schedule power on/ off times).

#### Lessons Learnt

**LL for further development of the SAMS HIVE system and the DW and DSS set-up**

- The configuration was iteratively simplified based on the experience from the workshop, so that barely any specific technical know-how is required to configure the systems via a web interface
- Status LEDs were developed based on the hints and questions for quick recognition of the system status for unskilled users
- The cable routing from the computer case to the sensor frame could be significantly improved by observing students to be trained during the installation of the systems, thus simplifying the installation

**LL for the conduction of further trainings and on provided learning materials**

- The training material was adapted to the needs of the students and thus also for the end user. Answers to frequently asked questions, such as the configuration of the data warehouse, were recorded in the manual
- From the experience gained in the training with the students, the basis was created for a lecture on the topic of digitalisation in agriculture and precision beekeeping. Here, the practical knowledge is to be built upon

# 3. Achievements and Lessons Learnt

This chapter summarizes the achievements and lessons learnt from the Capacity Building Program on DSS Implementation and Application.

## 3.1 Main achievements of the CB program

Table 6: CB and main achievements

| Country / Region | No. of trainings | Participants | Total No. of participants | Hours of training | Languages |
|---|---|---|---|---|---|
| **Ethiopia** | 9 trainings | Beekeepers, researchers, beekeeping experts | 293 participants (139 female) | 292hours (24 days) | English Amharic |
| **Indonesia** | 2 trainings | Beekeepers Internal SAMS team | 9 participants (2 female) | 14 hours (6 days) | Bahasa |
| **Europe** | 8 training | IT students | 65 participants (19 female) | 23 hours (4 days) | English, German |

In total, 19 trainings were given to 367 participants (160 female) in English, Amharic, German and Bahasa.

### Capacity building and knowledge transfer

In total, capacities and knowledge which were transferred through the training included:

- Knowledge transfer on the SAMS prototype components and on the software and hardware solutions developed within the SAMS project
- Introduction to ASS and DSS
- Developing in-depth understanding of bee management, particularly on seasonal colony management (active season colony management, dearth time colony management, transitional beehive construction), product diversification
- Practical field experience with the SAMS monitoring system and bee colony monitoring methods
- Knowledge transfer on the SAMS project, precision beekeeping, bee colony monitoring and the SAMS hardware as well as its usefulness for different field and stakeholders
- Knowledge transfer on the SAMS DW, its specifics and in connecting prototypes to the DW using specific credential file and authorisation procedure
- DSS interface usability tests with end user to adapt accordingly to ensures that the DSS could be used to its full potential
- try and test approach to building and configuration SAMS HIVE system's prototype based on Raspberry Pi

## Awareness creation

Additional focus was put on awareness creation on the benefits of ICT for apiculture. First CB activities showed that most beekeepers did not know about modern beekeeping technologies and modern beehive as well as on benefits of remote beekeeping technologies for beekeepers. Therefore, one main achievement of the trainings was successful awareness creation on ICT in apiculture and the SAMS HIVE monitoring system the related Data Warehouse, and on the usability of DSS for future beekeeping.

## Promotion of first monitoring system manufacturers in Ethiopia

Due to SAMS project awareness creation, two beehive monitoring manufacturers started to produce beehive colony monitoring prototypes. In addition, other five businesses started to produce modern beehives.

## Creation of employment opportunities

The CB program further served to create employment opportunities for participating beekeepers and teachers (particularly for women) by building capacity in beekeeping and promoting their involvement in SAMS business and in different marketing networks.

## Development of learning materials

Throughout the SAMS project time, a variety of learning materials were developed to pass on knowledge on modern beehive construction, the HIVE system, the SAMS Data Warehouse and DSS, and particularities of the local markets in Ethiopia and Indonesia. These training materials were developed in English language as well as in local language. Main materials

was published on the SAMS website and SAMSwiki where they are publicly available. The produced materials include manuals and presentations.

In addition, introductory videos on the DSS and on the SAMS monitoring system were created and published: SAMS Data Warehouse and SAMS ESP8266 system. The videos were shown and discussed during the SAMS Final Conference.

## Optimization of the SAMS Decision Support System

The program further served to gain better understanding of the needs and requirements of the SAMS users. Therefore, feedback on the SAMS prototype and DSS was collected from the training participants – different user groups, including beekeepers, researchers, beehive manufacturers, input suppliers as well as trainers in the field of apiculture. The feedback provided by participants was used within the UCD-cycle and mainstreaming of the SAMS HIVE monitoring system. All results of the conducted work and elaborated information were integrated into the transferability studies of the deliverables D6.2 Cross-Regional Transfer Study, D6.3 Transfer Study on Data Management and Utilization and D6.4 Transfer Study on Technology and Services.

## Ensuring long-term capacity building

Through networking and partnership activities, three partnerships were developed to foster long-term CB in the target regions and beyond, and to ensure further development and mainstreaming of the SAMS technology and results. Capacity building within the partnerships is based on supporting knowledge transfer, mutual learning between different stakeholders of the apiculture sector and scientific society. It further aims at creating capacity through dissemination of the SAMS technology and SAMS knowledge, as well as through testing of the SAMS HIVE system with beekeepers and beekeeping related start-ups. The three partnerships are described in depth in the project deliverable D6.1 Documentation of established Partnership Networks and Agreements. Main contact persons for the partnership can be found on the SAMSwebsite:

- **International Partnership on SAMS Business Development (PS1):** CB of beekeepers, beekeeping-related start-ups and beehive manufacturers in the application and marketing of the SAMS technology and through support in business development.
- **International Partnership on Bee Colony Data and Knowledge Exchange (PS2):** CB of beekeepers and start-ups through involvement in testing the SAMS Data Warehouse. Furthermore fostering knowledge exchange on modern beekeeping through SAMSwiki platform, as open source knowledge hub.
- **International Partnership on Apiculture Technology and Services (PS3):** CB through the involvement of beekeepers and bee breeders in testing of the SAMS HIVE monitoring system.

As several participants expressed interest partnering the CB trainings were further used to foster the development of local and international apiculture networks and to sustain the SAMS results in its target regions in the long term.

## 3.2 Main lessons learnt from the CB training

CB trainings were used as a form of continuous user-centred evaluation of the SAMS system and its related components (DW and DSS). Therefore, the SAMS Decision Support System and HIVE monitoring system were evaluated together with the participating beekeepers, scientists, input suppliers and other beekeeping experts. This provided insights on technological strengths and weaknesses of the device. Moreover, it allowed the SAMS team to adapt it for easier and more user-friendly construction ad use. Moreover, insights from the participants provided further information on needs and requirements of potential SAMS user and local conditions in which the system will be used (e.g. internet coverages, locally available materials, market structures).

### LL for the optimization of the SAMS system

- The configuration of additional devices involved, such as Wi-Fi router (used to transfer data from HIVE system to DW), should also be considered: as there were some issues with a network DNS (Domain Name Server), additional router configuration was needed to grant the access to the SAMS DW
- The human factor is very important to develop working prototypes
- Additional debugging options need to be considered to better back-trace errors occurring during system operation
- The DSS UI needs to be adjusted to the local context in which it is used and to the requirements of different stakeholder groups

### LL on the value of SAMS and the DSS for the participants / SAMS users

- The participating researchers, beekeepers and bee-experts agreed with the assumption that the SAMS system would be very helpful to work with the highly defensive honeybees in Ethiopia (remote real-time monitoring)
- Participating researchers and bee-experts confirmed the assumption that the DSS can increase the productivity of honey by reducing the disturbance of bees

### LL for the conduction of further trainings and on provided learning materials

- Some trainings should be split into multiple days

## 3.3 Challenges for the implementation of CB activities

Despite carefully planning and organizing the CB activities, not all aims could be achieved. Not all trainings could be implemented as planned and particularly female participation within the trainings was very low. This was due to unexpected challenges due to the COVID-19 pandemic, unrests in Ethiopia and other factors.

### Effects of Covid-19 pandemic

The pandemic Covid-19 situation required rescheduling and adaptation of all capacity building (CB) activities in all target regions conducted after February 2020. Some activities had to be cancelled due to restrictions on physical contact and travel. Virtual conduction was considered in the EU but was not as effective as personal trainings. Continuing restrictions on physical contact and travel, partnership affected the numbers of participants in trainings as well as the establishment of capacity building through international partnerships.

**Ethiopia: I**t was planned to conduct capacity building to 40 IT experts and other beneficiaries. However, due to Covid-19, only no experts were able to attend the CB training. Due to this pandemic, CB planned for March 2020, June 2020 and August 2020 were cancelled. This affected dissemination activities in Ethiopia seriously and only basic training was given in the implementation and application of the DSS.

**Indonesia:** Based on the assumption that the situation would improve after three to four months, capacity building activities planned in Indonesia were temporarily postponed in March 2020. After realizing that the pandemic situation would prevail until SAMS project end in December 2020, the conduction of online trainings was considered. Nevertheless, trainings for system implementation and modern beehive construction were not possible to be conducted as virtual trainings. Once the pandemic situation improved around June-July and citizens were well informed about hygiene measures (physical distance, mask wearing, etc.) a workshop could be realized with limited participants – in an open-air room and restricted time. Nevertheless, the limitations which came with Covid-19 led to reduced numbers of participants.

**Europe**: It was planned to conduct multiple CB activities in Europe (Latvia and Germany) focusing not only on the HIVE system and DW, but also on the developed DSS concept: rules for bee colony state detection (how to transfer them into “computer understandable” way), built analysis models, model usage in DW. The CB activities were planned not only for IT students but also for students from Faculty of Agriculture (potential and existing beekeepers). Due to the Covid-19 pandemic, restrictions were set that did not allow gatherings and organization of events.

## Effects of unrests in Ethiopia

CB planned for 9 IT experts two CB training planned for 82 beneficiaries were cancelled due to the recurring unrest in Ethiopia. As a result, planned activity for disseminating the technology and knowledge is highly affected.

## Reduced female participation

Within the programme, most female participants participated in trainings conducted in Ethiopia. Nevertheless, participation of women in trainings in Indonesia and Europe was relatively low.

- In **Ethiopia**, technology used within the beekeeping sector is not common and related knowledge is low. Not only the beekeeping sector is dominated by men, due to its risks, also the IT sector, which leads to a reduce female participation.
- In **Indonesia**, technology-related students are primarily male. But nowadays this paradigm is shifting due to active movement and encouragement of “woman in STEM (Science, Technology, Engineer, and Mathematic)” campaign. Moreover, beekeeping is still dominated by male actors, the wife’s and daughters usually support the

beekeeping activity. The reason why beekeeping is still perceived as “masculine” profession is mainly because bees have a dangerous stigma, and many beekeeping practices in Indonesia involving bee hunting in jungles, high trees, and death rate by non-domesticated bee stung are still occurring.

- In **Europe**, female participation was relatively low as the trainings were conducted in universities where the overall rate of female students in technical study programs is not very high. For example, at the Faculty of Information Technologies at Latvian University for Life Sciences and Technologies it is for example less than 10%.

## Delays in the development of the DSS

Difficulties in the development of the SAMS HIVE system, the linked Data Warehouse and the related DSS led to the point that CB on DSS implementation and application could not be completely realized as considered and planned. As the real-time data transfer of such SAMS monitoring systems to the SAMS Data Warehouse was not sufficient due to infrastructural aspects in the target countries but which is the key to develop the algorithm of the DSS to provide advice to beekeepers, the DSS could only be realized as DSS user interface and only this could be tested with beekeepers. Nevertheless, as the SAMS hive system and the SAMS Data Warehouse are strongly connected further indicators on the development could be extracted.

Amongst other factors, the Covid-19 pandemic contributed to delays in the development of the system. This led to difficulties in conducting in-depth training on the DSS and to conduct trainings for the target groups of “future SAMS providers” and software developers. Therefore, trainings were primarily directed to beekeepers, with the aim of raising awareness on the benefits of the DSS for bee colony management and to build capacity in basic understanding of the functionality and value of the DSS for their work.

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