International Partnership on Innovation

SAMS - Smart Apiculture Management Services

Deliverable N° 5.4

Capacity Building on Bee-Management and Bee-Health – Achievements and Lessons Learnt

N° 5 – Api-Management

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SAMS consortium partners

Logo	Partner name	Short	Country
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	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
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List of Abbreviations

CB	Capacity Building
DW	Data Warehouse
ET	Ethiopia
EU	European Union
ID	Indonesia
PS	Partnership
T	Training
TT	Training of Trainers
UCD	User Centered Design
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 (UCD) cycles, the development and adaption process of the SAMS hive system and the SAMS Datawarehouse and DSS, a capacity building (CB) program on bee-management and bee-health was developed. It was one of three CB programs conducted in the SAMS target regions Ethiopia, Indonesia and Europe. The three CB Programs were focused on the following 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 bee-management and bee-health were conducted in English language as well as in the local languages Amharic and Bahasa. The main target group of the trainings were beekeepers, and future SAMS operators. Main achievements of the trainings conducted in Ethiopia, Indonesia and Europe were:

- **Ethiopia**: conduction of 7 trainings for 258 participants from different regions in Ethiopia including beekeepers and honey producers. Trainings were conducted in Amharic and English language.
- **Indonesia**: conduction of 6 trainings for 108 participants including beekeepers, extension teachers, general public, and ex-UNPAD cleaning staff. Trainings were conducted in Sudanese and Bahasa.
- **Europe**: conduction of 4 trainings for 104 participants including veterinary students, biology teachers and beekeepers. The trainings were conducted in German language.

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 on bee-management and bee-health
- LL on SAMS business development in Ethiopia
- LL on the value of SAMS for the participants / SAMS users
- LL for the conduction of further trainings and on provided learning materials

1. The Capacity building program on bee-managmeent and bee-health

The capacity building (CB) program on bee-management and bee-health 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 D4.5 Capacity Building on Implementation and Application of the Decision Support Service – 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 and foster knowledge in bee-management and for appropriate and swift reaction to threat, especially for bee-health. Furthermore, the trainings served to gain a greater understanding of the user needs and related requirements for the SAMS system. The SAMS team thus used the trainings 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.

Main target groups for the trainings were existing and potential beekeepers, and future SAMS operators. Moreover, the training aimed at involving female participants in the training in order to meet the overall European Target of engaging female actors[1]. The training should enable them to gain in-depth understanding

- of bee-management and bee-health services for Indonesia, Ethiopia and EU, and
- on the application of bee management actions.

1.2 Analysis of local requirements

To ensure the maximum impact of the CB program, an analysis of modern beekeeping and related challenges of bee-management and bee-health in the target regions Ethiopia and Indonesia were conducted 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 bee-management and bee-health were defined in order to find common ground for the implementation of the activities.

1.2.1 Definition of bee-management and bee-health within SAMS

The importance of bee-management and bee-health within SAMS was defined as follows:

Bee health is strongly influenced by several factors, such as parasites, diseases, bee genetics, nutrition, pesticides, land use practices but also bee management aspects. **Bee-**

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

management is commonly practiced in beekeeping to keep the bees as healthy as possible and to maximize their productivity. Bee-management includes external hive/ apiary inspections as well as hive management. Latter is defined as active manipulation of a honeybee colony, to augment honeybee production and to ensure the survival of the colony. Common hive management practices include disease prophylaxis and treatment of infested colonies, swarm prevention/control, supplementary feeding, removing queen cells for swarm prevention, etc. Monitoring of bee-health is strongly connected to bee-management. Best practice bee-management must be adapted to local bee species and local environmental conditions. Therefore, the contextualizing of the bee sectors in Ethiopia and Indonesia was an important task. Nevertheless, specific rules on management apply in each context. Therefore 10 Rules of Honey Bee Management were developed and can be applied in every context.

More information on bee-management and bee-health in SAMS can be found in SAMSwiki, D5.2 Bee-Management and Bee-Health Database and D5.3 Evaluation Report on Bee-Management and Bee-Health Services.

1.2.2 Analysis of bee-management and bee-health in Ethiopia and Indonesia

An analysis of modern beehives in the target regions Ethiopia and Indonesia led to the following main findings. More information on bee-management and bee-health can be found in D5.1 Bee-Management and Bee-Health indicators, D5.2 Bee-Management and Bee-Health databases, D5.3 Evaluation Report on Bee Management and Bee-Health Services and on the SAMSwiki.

Table 1 Main bee-management and bee-health related challenges in Ethiopia and Indonesia

Ethiopia	Indonesia
• Beekeeping has a long tradition; therefore traditional beekeeping is still deeply rooted even though it implies lower productivity and sustainability • Problems on effective bee-management and product processing due to traditional beehives, diseases and pests of bees • Knowledge gap on advantages of transitional and modern hive systems and on manufacturing them • Knowledge gap on beeswax processing • Knowledge gap on bee-health and pest control • Low experience in marketing of bee-products	• Keeping bees in closed hive systems is a comparably new activity in Indonesia • Beekeeping is generally a small-scale business with low impact (side activity or used in local empowerment efforts) • Massive use of herbicides • No standardization for modern beehive dimension, every beekeeper has its ideal size and way of beekeeping • No standardization for beehive construction, every beekeeper has his/ her own technology and process • Low productivity due to used bee species (*Apis cerana* and *Trigona* spp.) and mismanagement • Decreasing number of bees and beekeepers • Decline in bee forage due to intensive farming (monocultures) and land functional shift

	• Climate fluctuations have direct impacts on drivers of ecosystem change such as drought, forest fire, flooding and the change of seasons time that leads to unexpected weather and affect colony management • No access to beekeeping training sites • No access to monitoring technology as this type of technology does not yet exist in Indonesia • Knowledge gap on post-harvest product handling

Ethiopia

In Ethiopia, Beekeeping is an old tradition and the potential for beekeeping is very high. But due to low level use of modern technology and knowledge gaps on bee-management and bee-health, beekeeping in Ethiopia is not done to its full potential. Beekeeping as a profession is appreciated only by a few individuals. Use of modern systems for beekeeping and product processing is very limited. Business development in beekeeping is very weak.

Indonesia

Even though beekeeping potential in Indonesia is great, there are lots of knowledge gaps as mentioned in the table above. Beekeeping in general is not considered as a promising profession and rather done as a side activity. Beekeepers in Indonesia construct their own beehives and have own methods for bee-management. The technology in apiculture is limited to bee product processing technology and no technology for monitoring bee-health exists yet in Indonesia.

1.2.3 Definition and analysis of the target group

Based on the above analysis, the target groups of the CB program and their expertise 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. This included extension teachers, biology teachers and students.

Ethiopia: In Ethiopia, traditional beekeeping is dominated by male beekeepers. Concerning gender, women are well represented in the overall field of beekeeping and its related activities but as beekeeping experts they are rare due to the nature of the work, as beekeeping activities are night activities that require long distances traveling to inspect the apiary and which leads to safety issues. Therefore, women are oftentimes not involved. Main CB challenges concerning bee-management and bee-health of beekeepers in Ethiopia are:

- Lack of knowledge and skill for seasonal bee-management

- Lack of trust from the beekeepers in using modern beehives
- Lack of knowledge in modern beekeeping (but knowledge in traditional beekeeping)

Indonesia: Beekeepers in Indonesia are dominated by senior beekeepers with age range above 35 years old. They mainly apply tacit knowledge in managing their colonies and use the communities' knowledge in beekeeping management. Concerning gender, in Indonesia beekeeping as a "profession" is still dominated by male actors, as bees have a dangerous stigma, while female actors (wife's and daughters) usually play a non-professional supporting role in the beekeeping business. Main CB challenges for bee-management and bee-health for beekeepers in Indonesia are:

- No access to beekeeping training sites which leads to weak knowledge on bee-management and bee-health
- Lack of interest in beekeeping as main job (not considered as a promising profession)
- Lack of knowledge about the application of modern technology for beekeeping, still traditional beekeeping
- Lack of knowledge in the treatment of post-harvest products

Future SAMS operators

Future SAMS operators were defined as beehive monitoring system manufacturers, ICT start-ups, ICT consultants, honeybee product value added traders.

Ethiopia: Main CB challenges the implementation and application of the DSS for this target group are:

- Lack of input materials for building the system
- Poor 3G network coverage
- Mobile network cutoff due to repeated unrest in the country

Indonesia: No training on future SAMS operators was conducted in Indonesia. All the participants are beekeepers and potential beekeepers.

1.3 Strategy for the conduction of the 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 where be carefully monitored for user-centred optimization of the SAMS system and adaptation of the CB program. Although activities were also conducted in Europe, the focus of the CB program laid on the SAMS target regions Ethiopia and Indonesia.

1.3.1 Capacity building through workshops and trainings

The implementation of workshops and trainings for CB on bee-management and bee-health, started with the first pilot implementation in March 2019 and April 2019 in Indonesia and Ethiopia and ended in December 2020. Main responsible partners for the implementation were HOLETA (Ethiopia) and UNPAD (Indonesia) and UNIGRA (EU).

Topics

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

Table 2 CB Topics

Leading question	Ethiopia	Indonesia	Europe
How to manage bees?	Yes	Yes	Yes
What to do for bee-health?	Yes	Yes	Yes
How to react to threats?	Yes	Yes	Yes

Participants

In addition to the main target group of the program (beekeepers and future SAMS operators), further stakeholders were invited to the CB trainings. These stakeholders included extension teachers, biology teachers and veterinary students. This served to create awareness and to disseminate knowledge amongst a greater range of stakeholders. In addition, it provided more feedback from a greater variety of stakeholders. Another factor was, that particularly extension teachers in Indonesia, biology teachers and students in the EU were considered as potential for future beekeepers, to create interest in new beekeeping technologies, raise awareness of their benefits.

Types of training and methodologies

The trainings consisted of theoretical and practical knowledge and expertise transfer on bee-management and bee-health. Different types of training were developed within the CB program:

- **Trainings for trainers/teachers**: to ensure long-term impact of the CB program by training future trainers of modern beehive construction and SAMS beehive construction. Trainings for extension teachers in Indonesia further aimed at building capacity in beekeeping to improve the welfare through introducing a side-activity/ second source of income
- **Workshops with Beekeepers**: to build capacity in bee-management and bee-health management and promoting the utilization of modern beehives amongst beekeepers (the end-users of beehives). They further aimed to create awareness on the benefits of modern beehives

- **Workshops with bee experts and researchers**: to build capacity and promoting the utilization of modern beehives amongst additional potential users of modern beehives. They further aimed to ensure long-term impact of the CB program by involving leading regional experts
- **Workshops with students:** to promote beekeeping and raise awareness on the importance of bee-management and bee-health amongst potential future beekeepers and experts
- **Site visits:** to attract participants' interest in beekeeping. By using this methodology, participants can get clearer pictures of beekeeping activities, bee-management and bee-health

Practical exercises included a land survey, colony transfer and placement.

Construction of beehives

To provide in-depth practical training and on bee-management and bee-health, it was planned to construct during the trainings:

- **Construction of transitional beehives**: As in Ethiopia beekeeping is still strongly driven by traditions the transitional beehives are considered as option to ease the transition from traditional to modern beekeeping.
- **Construction of beehive**: a commonly used Indonesian beehive is adapted from the Langstroth beehive but here does not exist standards for it.

Training materials

All trainings were supported by a variety of learning materials. The language of the materials was chosen by the implementing trainers, depending on the requirements of the training participants. Materials of the training are available on the SAMS website and SAMSwiki.

1.3.2 Long-term capacity building through SAMS partnerships

In addition to the training program, long-term partnerships on business development (PS1), bee colony data and knowledge exchange (PS2) and technology and services (PS3) between the SAMS partners and further stakeholder were established. Learn more about the partnerships here.

2. Conducted capacity building activities

This chapter provides an overview of capacity activities conducted in the target regions Ethiopia, Indonesia and Europe during SAMS project time. 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, 7 workshops were conducted for 258 participants from different regions in Ethiopia.

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 DSS (No. 1)	Beekeepers from Wodesa PA + 2 experts	Ambo	40 hours (5 days)	34 participants (5 female)	English	HOLETA
May 22nd – 26th, 2019	Workshop on Seasonal Colony Management, Bee-Health and DSS (No. 2)	Beekeepers from different sites of Wolmera districts	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 DSS (No. 3)	Beekeepers from Dendi District, Ejersa Lefo PA	Ginchi	40 hours (5 days)	31 participants (9 female)	Amharic	HOLETA
January 22nd- 23rd, 2020	Workshop on Seasonal Colony Management, Bee-Health and the DSS	Beekeepers from Guduru and Hababo Guduru Districts	Guduru, Kombolcha	15 hours (2 days)	40 participants (38 female)	Amharic	HOLETA
June 12th – 13th, 2020	Workshop on SAMS, Bee-Management, Bee-health and the DSS	Beekeepers from Borodo Water shade	Ginchi, Borod	15 hours (2 days)	31 participants (9 female)	Amharic	HOLETA

		area; Dandi beekeeping district experts					
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
September 5th - 7th, 2020	Workshop on Seasonal Colony Management and Transfer Hive Construction	Honey-producers coop	Ambo	18 hours (3 days)	42 participants (22 female)	Amharic	Ambo

2.1.1 Workshops on seasonal bee-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 to build capacity and provide in-depth knowledge on beekeeping equipment and its usage, with special focus on seasonal specifications and the establishment of colony management plans. Participants were beekeepers and beekeeping experts from Ambo, 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 new beehives system
- Day 2: Building capacity on seasonal colony management techniques
    - Active season colony management (identifications of seasons, inspection of colonies, swarm control and queen excluder insertion)
    - Dearth time colony management (reducing suppers/ reducing hive size in traditional and top bar hives, assisting bee colonies in cleaning of internal hive and removal of dried combs and managing wax mouth)
    - Practical transitional beehive construction and beehive stand construction
- Day 3: CB and knowledge transfer on product diversifications – beeswax, propolis, pollen
    - methods of harvesting and extraction / processing, types of tools/equipment used, and post-harvest management
- Day 4: Capacity building on bee-health and bee-health related problems, including bee diseases, pests and predators, locally used agrochemicals; and knowledge transfer on beekeeping business development
- Day 5: CB on the identification of bee diseases, pests, predators and agrochemicals, and possible control measures; as well as knowledge transfer on beekeeping businesses

Successful awareness creation on the SAMS beehive monitoring system and its usability for future beekeeping was done, as well as on the importance of beekeeping and product marketing. After the training, many participants were eager to own transitional hives and modern beehives by the end of the year. During the training 21 transitional beehives were build and bee colonies were transferred to 10 of those at beekeepers' apiaries. Furthermore, many participants were interested in joining one of the SAMS partnerships.

Lessons Learnt

LL on the value of SAMS for the participants / SAMS users

- As monitoring system use for apiculture is not common, participants understood that such technology is able to help them to improve their actions and become more efficient
- Nevertheless as the DSS is not finalized the connection between the system and their bee-management and related bee-health aspects were still abstract and the interlinkage must have been described and shown

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 and the management option for this different groups

Figure 1 separting honey from honeycombs harvested from traditional or transitional beehives by using honey press machine

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, as well as on the DSS. Participants were beekeepers and facilitators with knowledge gaps on bee management and bee health. Participants in the second training had already received training on the SAMS Decision Support Service in June 2019. Participants in the 3-day workshop were beekeepers from 2 coops in Wolmera districts who had already received CB training in May 2019.

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 demonstration of the SAMS prototype
    - 3-day WS: additional training in productive beekeeping site selection and bee forage improvement

- Day 2: Building capacity on active and seasonal colony management (identification of seasons, harvesting honey and processing, post- harvest management of bee products)
    - 2-day WS: Additional establishment of a colony management plan based on a (local) floral calendar and visit to a model apiary to learn about improving apiary management, production and productivity
- 3-day WS: Additional CB on dearth seasons colony managements (post-flowering): bee disease, pests and predator management, hive shade designing and apiary improvement

Successful awareness creation on the SAMS HIVE monitoring system development, its benefits and on the usability of DSS for future beekeeping. Participants considered to use the HIVE systems and change their beekeeping practice from traditional to modern in the future. Further trainings were requested to gain a greater understanding on such technology and its use. Furthermore, most participants of both trainings were interested in joining one of the SAMS partnerships. An additional aim of the training was to create employment opportunities for beekeepers (particularly for women) by supporting their involvement in SAMS business and different marketing networks. The 3-day workshop further was used to agree on a future work plan on how to improve the beekeeping activities.

Lessons Learnt

LL concerning bee-management and bee-health

- A major problem for most beekeepers is the lack of knowledge on the floral calendar and on how to manage colonies during different seasons
- Lack of knowledge on how to place beehives in the apiary
- Production and productivity of beekeeping is very low due to missing practical skills on colony management and bee-health and low frequency of honey harvesting (only once out of possible three times)
- Most beekeepers use traditional technology were inspections are mostly not foreseen
- There is a lack of market possibilities for bee products

LL for SAMS business development

- Market possibilities shall be facilitated and could be considered within the International Partnership on SAMS Business Development

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
- Provide in-depth knowledge on seasonal beekeeping

2.1.3 Workshop on seasonal colony management and transfer hive construction (3-day workshop)

In September 2020, a three-day workshop was conducted on seasonal colony management, bee forage improvement and transfer of bee colonies from traditional to modern hive. Participants were beekeepers and facilitators from a honey producer cooperation.

Achievements

Theoretical and practical training of 42 beekeepers and trainers, of which 22 were female:

- Day 1: Introduction to SAMS, honeybee colony monitoring methods including ASS and DSS, and introduction to new beehives systems
- Day 2: Building capacity on active season colony management (during flowering) and dearth seasons colony management (post flowering): identification of seasons, establishing a colony management plan based on a floral calendar and distinguishing ripen honey, harvesting and extracting
- Day 3: Building capacity on apiary site selection and beehive stand construction, bee-product and post-harvest management and marketing
- All 3 days: Practical training in the construction of transitional beehives from locally available materials and training on the procedure of transferring bee colonies from traditional to modern beehives for better management and productivity

An additional aim of the training was to create employment opportunities for landless youth, women and all participants through sustainable honey harvesting, bee product processing, and marketing networks. Participants considered to use the HIVE systems and change their beekeeping practice from traditional to modern in the future. Furthermore, most participants of the training were interested in joining one of the SAMS partnerships.

Lessons Learnt

LL concerning bee-management and bee-health

- Lack on seasonal management practices
- Lack on bee colony transfer
- Lack of knowledge on how to construct and use transitional beehives from locally available materials
- Availability of required material differs from region to region therefore alternatives may be required

LL for SAMS business development

- construction of transitional beehive gave them great opportunity to expand business activities

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

- a floral calendar for harvesting is a very important tool to harvest multiple times and to increase income

Figure 2 Construction of transitional beehive

2.2 Activities conducted in Indonesia

In Indonesia, 6 trainings and workshops were conducted for 108 participants from various regions. One of the trainings was especially dedicated to support the SAMS business model development (Bandung Bee Sanctuary)

Table 4 Activities conducted in Indonesia

Date	CB activity	Target group	Location	Duration	Participants	Language	Partner
October 2018 – January 2019	Beekeeping training for new beekeepers	Extension teachers	Bandung Regency & West Bandung Regency	3 hours (1 day)	29 participants (5 female)	Sundanese & Bahasa	UNPAD
March 30st, 2019	Beekeeping training	General Public	Bandung Regency	4 hours (1 day)	37 participants (27 female)	Sundanese & Bahasa	UNPAD
August – January, 2019	Beekeeping training for new beekeepers	UNPAD alumni and ex-cleaning staff	Bandung City	300 hours (60 days)	4 participants (0 female)	Sundanese & Bahasa	UNPAD
December 3rd, 2019	Workshop on Honey Quality	Beekeepers of KTH Karya Lestari & KTH Madu Lestari	Subang	4 hours (1 day)	3 participants (0 female)	Sundanese & Bahasa	UNPAD
October 30th-31st, 2020	Workshop on *Apis Cerana* Beekeeping & Modern Beehive Usability	Beekeepers	Banjaranyar, Ciamis	8 hours (2 days)	17 participants (0 female)	Bahasa	CVPI
December 22nd, 2020	Workshop on Bee Forage & Bee Derivative Products	Beekeepers & housewife	Banjaranyar, Ciamis	4 hours (1 day)	18 participants (13 female)	Sundanese & Bahasa	UNPAD

2.2.1 Beekeeping training for extention teachers

Between October 2018 and January 2019, extension teacher trainings were conducted. The trainings aimed to increase beekeeping capacity, awareness and to promote beekeeping as side income. Participants were middle and high school, located in Arjasaari sub-district of Bandung Regency. Those teachers are close to the youth and can promote the importance of bees and beekeeping among the students. Not all participants were able to participate in all activities due to overlaps with their teaching schedules.

Achievements

Theoretical and practical training of 29 extension teachers, of which 5 were female:

- Day 1: Training on honeybee Cultivation: introduction to beekeeping in Indonesia and worldwide, and introduction to SAMS and its aims
    - Introduction to types of bees, types of feed, pests and diseases and how to handle them, bee products, equipment used in beekeeping, honey harvesting
- Day 2: Site visits to a honeybee farm in Mekarwangi District (West Bandung Regency) for practical experiences with honeybees
    - CB on identifying pests and diseases that attack bee colonies, causes of blurred colonies, and pesticide problems – and how to prevent and overcome them
    - CB on Honey marketing
- Day 3: Land suitability survey with honorary teachers on the suitability of land in supporting beekeeping: availability of food of bees, aspects of safety, the environment, the possibility of pesticide contamination
- Day 4: CB on the delivery and transfer of bee colonies for direct application of the knowledge gained in the previous activities
    - Knowledge transfer on techniques for transferring honeybee colonies in the beehive
    - CB on techniques in moving and placing the beehives right

One aim of the activity was to increase the welfare of participants by making beekeeping a source of income, either by selling honey products produced or as a source of honey consumption for participants. Many participants confirmed that honey raising/ beekeeping could become a helpful side work which would not interfere with their main activities. Some participants started beekeeping activities right after the CB. Furthermore, the activity aimed to raise public awareness about the importance of bees, environmental sustainability and behaviour patterns around the forest.

Lessons Learnt

LL concerning bee-management and bee-health

- Different level of knowledge and experiences among participants, particularly in hunting honey from wild colonies in the forest

LL on SAMS business development

- Extension teachers confirmed that beekeeping was a suitable side work

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

- Main challenges during the training were the attendance of participants as they also had to carry out their teaching duties – time slots need to be considered

Figure 3 Showing *Apis cerana*, delivery and installation of bee colonies

2.2.2 Beekeeping Training

On March 30, 2019, a beekeeping training for participants from the general public was held in Mekarjaya Village, Arjasari District, Bandung Regency. The participants came from various groups around the edge of the forest. The training was focusing on awareness and the means of bee-health as driving force for the environmental conditions.

Achievements

This activity was attended by 37 participants, of which 27 of them were female. Participants received training in:

- Introduction to beekeeping in Indonesia and to product marketing
- Discussions on own experiences with bees and beekeeping, as well as wild honey hunting
- Introduction to bee colonies, beehives and the harvesting process
- Further knowledge transfer on types of honeybees, types of bee feed, pests and diseases of honeybees, equipment used in beekeeping, products produced by bees, how to harvest honey, its time and technicalities
- Introduction to SAMS and its benefits

Lessons Learnt

LL concerning bee-management

- participants became aware of the imortance of bees and the possbility on becoming a beekeeper to gain further income
- Some of the participants, who are ot actual beekeeper are experienced with wild honey hunting

Figure 4 Mr. Yadi while explaining beekeeping activites and during discussion session

2.2.3 Workshop on honey quality

In December 2019, a workshop on honey quality was conducted in Subang. The activity aimed at creating capacity in maintaining the quality of honey produced. Participants were beekeepers located in Subang, a region that is famous for rambutan flower nectar. As beekeepers are located in the only migratory beekeeping centre in West Java, the beekeepers there must have the capacity to maintain the quality of honey.

Achievements

Training of four beekeepers:

- CB on maintaining the quality of the honey produced: reducing water content in honey, maintaining honey quality during storage and by screening it before packaging, reducing honey contamination
- Introduction to SAMS and its benefits

The activity included interviews and observations on an *Apis mellifera* bee farm in Subang Regency to gain insights in local beekeeping methods and opening a dialogue with the local beekeepers.

Lessons Learnt

LL concerning bee-management and bee-health

- Insights gained on the characteristics of the start and end of spring rambutan season
- Insights gained on local knowledge on environmental conditions and harvesting possibilities related to rambutan - production can reach 15 kg/ beehive box/ 1 week
- Insights on harvesting process and its related water content issues - based on interviews, mellifera beekeepers will directly harvest honey when the hive (comb) is full or they harvest honey when the honeycomb has been filled with a minimum of 60% honey
- Insights on further process of harvested honey – packaging and storing
    - One important fact - farmers do not use gloves or clean areas for the process, so the hygiene process is not maintained

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

- Increase awareness of harvesting and hygiene processing process
- Create awareness on the fact that consumer care about the quality

Figure 5 Honey filtering technique before honey is stored and small size extractor.

2.2.4 Beekeeping training for new beekeepers

Between August 2019 and January 2020, a beekeeping training was conducted for new beekeepers at a beekeeping location owned by senior beekeepers. Participants were previous UNPAD employees, former security and potential beekeeping business activists to provide them new opportunities for their income.

Achievements

Training of four new beekeepers:

- Practical training in constructing and building beehives, transferring bee colonies, interaction with bees, observing/ checking the condition of bee colonies, moving wild bee colonies into beehive boxes, and harvesting honey
- Practical and theoretical training in land preparation – types of forage

After the training, the new beekeepers were able to carry out beekeeping activities. They expressed interested to start own beekeeping activities and/or to start work as beekeeper at Bandung Bee Sanctuary (BBS). The new beekeepers learnt and understood the beekeepers' daily life and were able to replicate these daily activities at BBS.

Amongst the participants, potential SAMS businesses were identified.

Lessons Learnt

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

- Main challenges faced during the conduction of the training were the suitability of senior beekeepers' schedules, field conditions (bee colony conditions, bee feed, search of wild colonies for direct practice material, etc.)

Figure 6 Studying and preparing bee forage and practicing catching a colony, the method of capturing and moving bee colonies

2.2.5 Workshop on *Apis Cerena* beekeeping and modern beehive usability

In October 2020, a training on *Apis cerana* beekeeping and modern beehive usability was conducted. Participants were grassroot beekeepers in rural areas.

Achievements

Theoretical and practical training of 17 beekeepers:

- Training in the usability of modern beehives and the SAMS monitoring system
- Field trip to the apiary site on KTH Bina Lestari in Village Banjaranyar, Ciamis regency area: demonstration how to maximize beekeeping potential by using modern beehives
- Knowledge exchange on *A. cerana* beekeeping methods and maximizing the potential of modern beehives usability

Lessons Learnt

LL for the optimization of the SAMS system

- Further needs and requirements which should be fulfilled by the SAMS system or similar ones - grassroot beekeeper wish to monitor their deep-in-the-forest “beehive trap”

LL for SAMS business development

- KTH Bina Lestari are potential partners for SAMS business

LL on bee-management and bee-health

- Beekeepers need to be able to place the system deep in the forest where they place beehives waited for bee colony to inhabit it – infrastructural aspects are not perfect yet

LL on the value of SAMS for the participants / SAMS users

- The participating beekeeper found that the technology could be very useful for more effective bee monitoring

LL for the conduction of further training and on provided learning materials

- According to participants’ feedback, one of the most valuable learnings from the training was awareness creation when it comes to specific bee forage

Figure 7 Discussion on optimizing modern beehives (above) and demonstrating SAMS HIVE monitoring system implemented in the modern beehive (below)

2.2.6 Workshop on bee forage management and honey derivative products

On December 22, 2020 the UNPAD SAMS team conducted a CB activity under the theme of bee forage and bee derivative products. Five beekeepers from the KTH Bina Lestari group and 13 women from Banjaranyar village participated in the training.

Achievements

Capacity building of 18 participants, of which 13 were female:

- Training related to the use of bee forage as a revenue stream and bee forage management
- Training in making two recipes for honey derivative products

Lessons Learnt

LL concerning bee-management and bee-health

- Insights gained on environmental conditions and available bee forage in the area
- Insights on the commonly used bee types in the area - Apis mellifera and two Trigona types - Trigona leavicep and Trigona biroi
- Insights on the beekeeping conditions and support in the area
    - The community supports the group's beekeeping program
    - Local and provincial government programs that are aligned with the development of honey villages
    - The existence of community efforts in developing honey villages
    - Each house has some beehives

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

- Local beekeepers and communities are keen on receiving more training, especially under the focus of becoming a honey tourism village
- Beekeepers request more technical beekeeping training
- The community, especially women, are very happy with the bee derivative products

Figure 8 Opening of bee forage and honey derivative products workshop and demo of products

2.3 Activities conducted in Europe

In Europe, 4 trainings were conducted for 104 participants including beekeepers, biology teachers and veterinary medicine students.

Table 5 Activities conducted in Europe

Date	CB activity	Target group	Location	Duration	Participants	Language	Partner
October 12th, 2019	Lecture on Honeybee Pollen Availability and Bee-Health	Beekeepers	Völkermarkt Carinthia, Vienna (Austria)	4 hours (1 day)	52 participants (10 female)	German	UNIGRA
October 25th, 2019	Training of Trainers on SAMS Honeybee Monitoring, Honeybees and Pollination	Biology Teachers	University of Graz (Austria)	2 hours (1 day)	18 Participants (15 female)	German	UNIGRA
May 15th, 2020	Workshop on Breeding and Health in the Light of SAMS	Students of veterinary medicine	Veterinary University of Vienna (Austria)	3 hours (1 day)	13 participants (7 female)	German	UNIGRA
November 27th, 2020	Training of trainers on the importance of bees, honeybee monitoring and the SAMS project	Biology Teachers	University of Graz, Graz (Austria) - virtual	2 hours (1 day)	21 participants (18 female)	German	UNIGRA

2.3.1 Lecture on honeybee pollen availability and bee-health

In October 2019, a lecture on honeybee pollen availability and bee-health in Austria was conducted in Völkermarkt/ Carinthia and in Vienna. Participants were beekeepers and bee breeders with diverse knowledge – ranging from less to fully experienced.

Achievements

Theoretical and practical training of 52 beekeepers and bee breeders (of which 10 were female):

- Building capacity in monitoring the environment
- Knowledge transfer on the importance of the environment for colony development and bee-health, the small hive beetle Vespa velutina, pollen diversity, available pollen sources in Austria and bee-health

The participants gained increased awareness on the importance of the environment for colony development and bee-health, and for the importance of the small hive beetle, Vespa velutina.

Lessons Learnt

LL on the value of SAMS for the participants/ SAMS users

- Some of the beekeepers know about the advantages of monitoring systems in beekeeping, but most of them never heard about such systems before. They interestingly followed the lecture and gave the feedback, that the SAMS system and monitoring systems in general are potentially attractive for them and their work.

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

- The most interesting learnings for the participants were about pollen diversity and differences of pollen diversity from region to region, seasonal differences in pollen diversity, and advantages of bee monitoring systems for beekeepers.

Figure 9 Trainer Robert Brodschneider holding the lecture

2.3.2 Training of trainers on SAMS honeybee monitoring, honeybees and pollination

In October 2019, a lecture on honey bee pollen availability and bee-health was conducted in Graz. Participants were bachelor´s with a degree in biology and in diverse second bachelor´s program who had basic knowledge in the field of biology, some already had experiences with bees. In Austria, bachelor´s degree already teach in schools, but need to part-type study in a master´s program for their specific fields.

Achievements

Theoretical and practical training of 18 teachers (of which 15 were female):

- Introduction to the SAMS project and its benefits
- Introduction to the importance of honeybees for the society (income, rural development) and ecosystems (pollination)

The participants gained awareness for the importance of honeybees. They learned about the existence, importance and potential of the SAMS project, monitoring systems and the SAMS system. As they did not know about bee monitoring systems before, they were fascinated about the possibilities of such a system. As biology teachers, they hopefully pass on that information to their students which will again benefit from the knowledge.

Lessons Learnt

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

- Participants were very interested and asked many questions.
- Some participants were a little overwhelmed, because some of them had not experiences with bees and they heard about bees, their biology and bee colony monitoring for the first time.

Figure 10 Participants of the lecture

2.3.3 Workshop on breeding and health in the light of SAMS

In May 2020, a workshop on bee breeding and health was conducted at the Veterinary University of Vienna. Participants were students of veterinary medicine who have chosen the course “beekeeping” as an elective subject.

Achievements

Theoretical and practical training of 13 veterinary students:

- CB on tools and equipment for beekeeping and bee breeding, learn about bee genetics, bee-health, beekeeping and bee breeding
- Demonstration of tools and equipment used for beekeeping and especially for queen breeding: queen breeding equipment such as EZI Queen System (for beginners of queen rearing; no-touch system that does not require grafting), Nuc boxes (a box, where you place a frame with bee cells), queen rearing cups, grafting materials, etc
- Talk about the benefits of monitoring systems for queen breeding Lessons Learnt

According to the participants, the training was conceived as successful and meaningful, and they were able to improve their beekeeping skills.

Lessons Learnt

LL on the value of SAMS for the participants/ users

- The participants did not know about bee monitoring systems before. They thought the system is meaningful, but not developed fully yet

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

- The practical insights from a professional were highlighted as very positive
- Due to the COVID-19 measures, the group work was difficult to conduct, but the participants showed much effort

Figure 11 Learning about bee breeding and health in the light of SAMS, COVID-19 measures demand mouth/ nose protection

2.3.4 Training of trainers on the importance of bees honey bee monitoring and the SAMS project

On November 27th, 2020, a lecture similar to the Training of Trainers event in October 2019 on the importance of bees, honeybee monitoring and the SAMS project was conducted virtually (due to COVID-19). Participants were bachelor´s degree in biology and in diverse second bachelor´s program who had basic knowledge in the field of biology, some already had experiences with bees. In Austria, bachelor´s degree already teach in schools, but need to part-type study in a master´s program for their specific fields.

Achievements

Theoretical training of 21 teachers (of which 18 were female):

- Introduction to the SAMS project
- Introduction to the importance of honeybees for the society (income, rural development) and ecosystems (pollination)

The participants gained awareness for the importance of honeybees. They learned about the existence, importance and potential of the SAMS project, monitoring systems and the SAMS system. They further learned about the inter-linkages of SAMS and the fight against poverty as well beekeeping for sustainable development. As they did not know about bee monitoring systems before, they were fascinated about the possibilities of such a system. As biology teachers, they hopefully pass on that information to their students which will again benefit from the knowledge.

The feedback was overall positive, and the most mentioned strengths of the training were:

- The lecturer itself (expertise, set up of the training)
- Images and graphs in the presentation (inspiring for teaching lessons of biology teachers)
- SAMS project is inspiring
- Lecturer told about his own experience with bees (he is not only a bee expert, but also a beekeeper)
- New information was provided to the participants

Lessons Learnt

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

- Trainings about animal husbandry needs a practical part to fully understand the living being and its way of life as well as to get a feeling for the work with animals
- An excursion to beehives is mandatory
- Importance of using interactive ways to introduce the topic (short discussions, etc.)

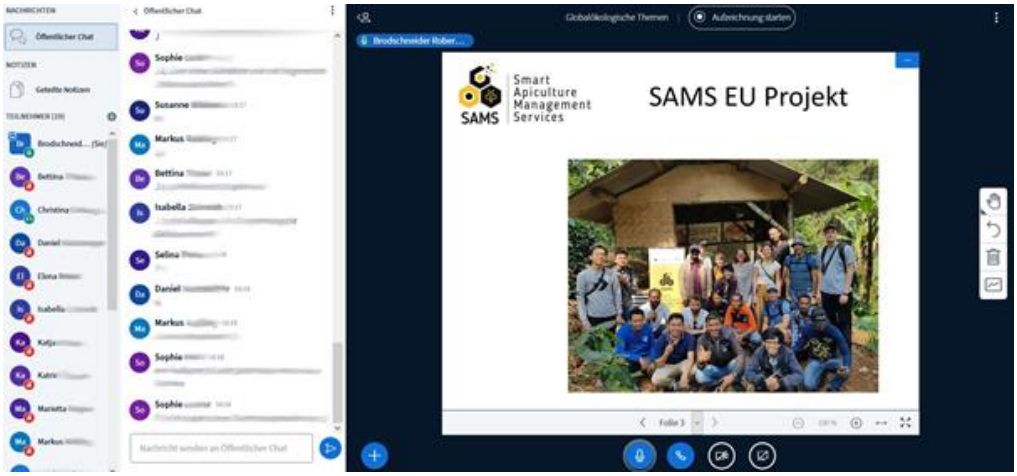

Figure 12 Virtual capacity building event with Austrian biology teachers

3. Achievements and lessons learnt

This chapter summarizes the achievements and lessons learnt from activities conducted between 2018 and 2020 within the capacity building program on modern beehive construction.

3.1 Main achievements and lessons learnt

This chapter summarizes the achievements and lessons learnt from the capacity building program on modern beehive construction.

Table 6 CB and main achievements

Country / Region	No. of trainings	Hours of training	Total No. of participants	Participants	Languages
Ethiopia	7 trainings	183 hours (25 days)	258 participants (155 female)	Beekeepers and beekeeping experts	English Amharic
Indonesia	6 trainings	323 hours (66 days)	108 participants (45 females)	Beekeepers, extension teachers, general public, UNPAD alumni, and women	Bahasa Sundanese
Europe	4 trainings	11 hours (4 days)	104 participants (50 female)	Beekeepers, biology teachers, students of veterinary medicine,	German

In total, within 17 trainings 470 participants were trained on bee-management and bee-health topics.

Capacity building and knowledge transfer

Capacities and knowledge which were transferred through the training included:

- Knowledge transfer on the SAMS prototype components and on the hardware and software solutions developed within the SAMS project

- Knowledge transfer on the SAMS project, including the ASS and DSS and the SAMS hardwarePractical 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
- Knowledge transfer on bee-health and bee-health related problems, including the identification of bee diseases, pests, predators, and locally used agrochemicals
- Knowledge transfer on beekeeping business development and honey marketing
- 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
- Building capacity on productive beekeeping site selection and bee forage improvement
- Training on Honeybee Cultivation: introduction to beekeeping in Indonesia and worldwide, and introduction to SAMS and its aims
- Site visits to honeybee farms in Ethiopia and Indonesia
- Installation and fixing honey comp boxes
- CB on maintaining the quality of the honey produced in Indonesia: reducing water content in honey, maintaining honey quality during storage and by screening it before packaging, reducing honey contamination
- Training in construction of honeycomb boxes and beehive boxes
- CB in monitoring the environment (Europe)
- Knowledge transfer and awareness raising on the importance of the environment for colony development and bee-health, the small hive beetle, predators like *Vespa velutina*, pollen diversity, available pollen sources in Austria and bee-health
- Introduction to the importance of honeybees for the society (income, rural development) and ecosystems (pollination)

Awareness creation

Additional focus laid on awareness creation related to benefits of ICT for apiculture and on the importance of bee-health. First CB activities showed that most beekeepers in Ethiopia and Indonesia did not know about modern beekeeping technologies and modern beehives and that there was a great knowledge gap on the application and benefits of remote beekeeping technologies for beekeepers. After the trainings, most participates considered to use the HIVE systems and change their beekeeping practice from traditional to modern in the future.

Construction of beehives

For in-depth training in bee-management and to transfer knowledge on the managing bees in modern hives, different types of beehives were constructed within the trainings:

- **Construction of beehives**: No beehives constructed; however, the participants gained knowledge on how to construct/repair a beehive through training.

- **Construction of transitional beehives**: 20 transitional beehives were constructed during trainings conducted in Ethiopia. Transitional beehive was constructed from local available materials.

Optimization of the HIVE monitoring system

The program further served to gain better understanding of the needs and requirements of the SAMS users. Therefore, feedback was collected from the workshop and training participants. The feedback 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.

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.

Conduction of a land suitability survey in Indonesia

In Indonesia, a a survey was conducted with extension teachers on the suitability of land for the support of beekeeping: availability of food of bees, aspects of safety, the environment, the possibility of pesticide contamination. The land suitability survey was carried out by inviting several participants. The aim was to find out what types of plants dominate in several potential locations for beekeeping. Participants are invited to pay attention to environmental conditions as well, whether there are reports of wild bee colonies in potential locations, then participants are also given knowledge about the types of plants that can be used as food for bees. In addition, participants were also invited to calculate the distance between the closest plantations that use pesticides to potential beekeeping locations.

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.

Development of a future work plan for improvement of local beekeeping

Within the CB activities conducted in Ethiopia, future work plans were developed, together with partners, to improve local beekeeping activities by disseminate beehive monitoring systems and SAMS beehives during after the project end. HOLETA is planning to develop the capacity of the participants in cooperation with the Ethiopian job creation commission in the coming three years.

3.2 Main lessons learnt from the CB training

The CB trainings were used as a form of continuous user-centred evaluation of the SAMS system – particularly regarding issues related to bee-management and bee-health monitoring and management. 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 into technological strengths and weaknesses of the system. Moreover, it allowed to make conclusions on needed adaptions for easier and more user-friendly construction of the system. As previously described, insights from the participants served to gain new input in the needs and requirements of potential SAMS users and local conditions in which the system will be used (e.g. internet coverages, locally available materials, market structures).

LL for the concerning bee-management and bee-health

- Major lack of capacity and knowledge identified in Ethiopia on the floral calendar, seasonal colony management and placing beehives in the apiary
- In Ethiopia, a low productivity of beekeepers was observed despite rich potential resources. Main reasons for low productivity were lack of practical skills on colony management and bee-health and low frequency of honey harvesting, use of traditional technology
- Limited availability of material to construct and build own modern beehives
- insights into the characteristics of spring commencement and end in rambutan plants, bee-management and honey processing techniques in Indonesia (see Workshop on Honey Quality, Indonesia)

LL for SAMS business development in Ethiopia

- Many beekeepers were interested in SAMS business development and in cooperation with the International Partnership on SAMS Business Development
- In Ethiopia, the support of a bee product market needs to be facilitated
- Trainings on the construction of transitional beehive in Ethiopia were helpful for the participants to give them the opportunity to expand their improved beekeeping as well as the potential for business development
- trained teachers in Indonesia consider beekeeping as side work
- Indonesia, an important learning was the importance to also raise awareness on honey quality amongst consumers (not only amongst beekeepers)

LL on the value of SAMS for the participants / SAMS users

- Most participants did not know about the health and management possibilities bee monitoring systems can provide to them and how they could make use of them

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

- Importance of practical training on bee-management, particularly on how to identify and manage weak, medium and strong colonies
- Importance of practical training on how to utilize the modern beehive in the field
- Lack of knowledge on how to construct and build transitional beehives from locally available materials
- Main challenges during trainings became the time aspects and when such trainings shall be conducted especially for those participants who are not yet beekeepers and would only consider beekeeping as side work (e.g. teachers)

3.3 Challenges for the implementation of CB activities

Despite carefully planning and organizing the CB activities, not all trainings could be implemented as planned 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 for sure not as effective as personal trainings. Continuing restrictions on physical contact and travel affected the numbers of participants in trainings.

Ethiopia: Due to Covid-19 planned CB activities for female beekeepers and beekeeping experts were cancelled. The CB trainings were planned for March and May 2020. Online workshops were not considered e.g. due to infrastructural aspects.

Indonesia: physical contact and travel restrictions made it difficult to realize physical events, especially in the beginning of the Covid-19 pandemic. The application of health protocols such as wearing masks, limiting participants, etc. affected the number of participants in the trainings. Trainings could only be conducted with limited numbers of participants. Online workshops were not considered e.g. due to infrastructural aspects.

Europe: In Europe CB activities were also strongly affected by the pandemic. Most of the CB events were planned as a mixture of theoretical and practical background. Latter was done by e.g. demonstrating beekeeping equipment and by an instruction on how to use them or by visiting beehives and learning on site. With the pandemic, it was decided to switch to virtual events, as practical activities had to be dropped completely. Further, attendants were provided more background on bee biology and for example on forage plants and generally it was focused on pointing out how important bees are for the environment. Especially younger individuals attended the online events. In one special case, it was planned to conduct a CB event with 10-15 influential beekeepers and beekeeping activists which consisted of mainly people being 50 and older which were cancelled, due to COVID-19, as they are not as adept as younger generations to virtual events.

Effects of unrests in Ethiopia

Three capacity building trainings for beekeepers were cancelled end of June 2020 due to unrests in the Oromia reginal state. As a result, the planned capacity was reduced by 80 participants. Further unrest influenced planned CB actions and SAMS hive implementation.

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