International Partnership on Innovation

SAMS - Smart Apiculture Management Services

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Compendium of SAMS publications and press releases

Work Package 7 – Dissemination and Communication

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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	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

Auth0	Authorization
BSON	Binary JavaScript Object Notation
DisComEx	Dissemination, Communication, Exploitation
DMS	Data Management System
DoA	Description of the Action
DSS	Decision Support System
DW	Data Warehouse
EC	European Commission
e.g.	for example
EU	European Union
FAIR	Findable, Accessible, Interoperable and Re-usable
FP7	EU 7th Framework Programme for Research
GA	Grant Agreement
GDPR	General Data Protection Regulation
IDMP	Initial Data Management Plan
ICT	Information and Communication Technology
ITAPIC	Application of Information Technologies in precision Apiculture
JSON	JavaScript Object Notation
MIT license	Open Source license of Massachusetts Institute of Technology
MongoDB	Database Management System
MS	Microsoft
OpenAIRE	European Open Science Infrastructure, for open scholarly and scientific communication
PR	Public Relations
SAMS	Smart Apiculture Management Services
UCD	User Centered Design
UN	United Nations
Web API's	application programming interface for a web server or web browser

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

Contents

Executive summary

The report provides information on publications and press clippings of the SAMS project. Such dissemination activities were planned and carried out with the aim of informing interested organisations and general public outside the consortium about the project concepts, its progress and achievements. Dissemination and communication activities on project results are organised and supervised by GIZ, with the support of all the partners. quarterly newsletter will be published on the project website. All participants commit themselves to issue publications on concept and proceedings of SAMS in local, national, or European technical magazines, or public media.

Overall the reports consist of 16 press clippings for Indonesia, 1 press clippings for Ethiopia, 9 press clippings for Europe and 14 publications as well as 3 upcoming publications.

Besides those action the consortium has published its own SAMS newsletter quarterly. A compendium of the newsletter is available on the SAMS website, were also each individual Newsletter can be downloaded. Only non-confidential results were disseminated throughout the project implementation.

Twitter actions are not provided within this report even so it relates to public media. Individuals who are interested in SAMS twitter post can check them out. Over the project duration 484 tweets were generated.

1. Press Clippings

1.1 Indonesia

1.1.1 July 19,2018 – [Republika](#) – Unpad Holds Riung Karsa


REPUBLIKA.co.id

Thursday, 25 Rabiul Akhir 1442 / 10 December 2020

HOME NEWS NUSANTARA KHAZANAH ISLAM DIGEST INTERNASIONAL EKONOMI REPUBLIKBOLA LEISURE PIKADA 2020 KOLOM REPUBLIKA TV KONSULTASI LAINNYA

Home > News > Pendidikan

Unpad Gelar Riung Karsa

Kamis 19 Jul 2018 14:44 WIB

Red: Rahmat Santosa Basarah

Rektor Unpad Prof. Dr. med. Tri Hanggono Achmad — Foto: Republika/Edi Yusuf

Riung Karsa mengundang kolaborasi yang lebih banyak dengan masyarakat luas.

REPUBLIKA.CO.ID,JATINANGOR--Universitas Padjadjaran akan menyelenggarakan Press Gathering dalam rangka menyosialisasikan dan mempromosikan produk-produk hasil riset unggulan yang saat ini banyak dihasilkan oleh para peneliti di Unpad. Program ini akan dikemas dalam bentuk obrolan santai sambil minum kopi di sore dan diberi nama Riung Karsa (Riset Unggulan Unpad Dan Kerjasama Untuk Masyarakat Sejahtera). Riung Karsa akan menjadi media branding hasil riset dan inovasi berkelas dunia yang memiliki dampak dan kontribusi bagi masyarakat. Program ini akan rutin diselenggarakan setiap minggu pada hari Jumat pukul 15.30 – 16.30 WIB di Unpad Training Center , Jl. Ir. H. Juanda no. 4 Bandung.

Kepala Kantor Komunikasi Publik Unpad, Ade Kadarisman,S.Sos., M.T., M.Sc mengungkapkan Riung Karsa adalah wahana Unpad untuk ngahiji dengan masyarakat melalui kehendak, cita-cita Unpad sebagai World Class University, Serta membangun masyarakat sejahtera berbasis riset unggulan dan kerja sama Unpad. "Dengan kerja sama sebagai kunci, Riung Karsa mengundang kolaborasi yang lebih banyak dengan masyarakat luas untuk bersama-sama menuju masyarakat kelas dunia. Selain menghadirkan narasumber para peneliti yang telah melakukan riset berkelas dunia serta berkolaborasi dengan pihak-pihak terkait dan memiliki dampak bagi masyarakat Indonesia khususnya dan masyarakat dunia umumnya," papar Ade pada *Republika*.

Saat ini Unpad memberikan kesempatan bagi dosen peneliti dan tenaga kependidikan untuk menyelenggarakan aktivitas riset dan pengabdian kepada masyarakat. Di awal 2018 Unpad telah membuka pengajuan proposal baru dan lanjutan kegiatan Hibah Internal Riset dan Pengabdian pada Masyarakat. Ada tujuh skema riset yang ditawarkan Unpad kepada dosen dan tenaga kependidikan, yaitu Riset Dosen Pemula Unpad (RDPU), Riset Academic Leadership Grant (ALG), Riset Fundamental Unpad (RFU), Riset Kompetensi Dosen Unpad (RKDU), Riset Kolaborasi Internasional Unpad (RKIU), Riset Hilirisasi Produk Unggulan (RHPU), dan Riset Tenaga Kependidikan Unpad (RTKU).

Terwujudnya sebuah program memerlukan proses dan kolaborasi. Dalam hal ini Unpad berupaya fokus memformulasikan content, digital platform dan diseminasi informasi melalui berbagai program sehingga bisa dirasakan manfaatnya oleh publik. Program ini tidak akan berjalan dengan baik tanpa dukungan seluruh unit kerja baik di tingkat Universitas maupun Fakultas. Selain itu kolaborasi dengan semua pemangku kepentingan menjadi keberhasilan program ini.

Menurut Ade, melalui dukungan dari berbagai media, diharapkan berbagai karya riset dan inovasi dapat semakin membumi, memiliki manfaat dan nilai tambah bagi khalayak luas. Sebagai permulaan Riung Karsa akan mengangkat sebuah penelitian yang dilakukan oleh Smart Apiculture Management Services (SAMS). SAMS merupakan project riset internasional dibawah program Horizon 2020 ICT-39 Uni Eropa dengan tema kemitraan internasional dalam membangun negara-negara berpendapatan menengah dan menengah ke bawah. Projek ini bertujuan untuk meningkatkan kerjasama internasional (ICT) dan pertanian berkelanjutan antara Uni Eropa dan negara-negara berkembang dalam mengejar komitmen EU untuk mengakhiri kelaparan, mencapai ketahanan pangan dan peningkatan gizi serta mempromosikan pertanian berkelanjutan.

UNPAD HOLDS RIUNG KARSA

Universitas Padjadjaran will hold a press gathering in order to socialize and promote superior research products resulting from UNPAD researchers. This gathering is called Riung Karsa; an abbreviation for UNPAD Flagship Research and Collaboration for a Prosperous Society; that will be held every Friday afternoon at the UNPAD Training Centre. The gathering is served in a casual conversation style. This gathering is the kick-off event for the series of Riung Karsa and is initiated due to UNPADs involvement in the international research project Smart Apiculture Management Services (SAMS) which is funded by the Europeans Union Horizon 2020 Research and Innovation program. The project aims to promote international cooperation in ICT and sustainable agriculture between the European Union and developing countries and supporting the EU within its commitment to end hunger, achieve food security, improve nutrition's and promotes sustainable agriculture.

1.1.2 July 20,2018 – Website University Padjadjaran – Riung Karsa, Unpad Flagship Research and Collaboration for the Community

Riung Karsa event poster with topic of UNPAD involvement in Smart Apiculture Management Services (SAMS); an international research project.

1.1.3 July 21,2018 – Tribun Jabar – UNPAD develops Beekeeping Research for Sustainable Forests and Prosperous Communities

TribunJabar.id

Kamis, 10 Desember 2020 Cari

Home News Metro Bandung Jabar Region Bisnis Sport Persib Mania

Home > Metro Bandung > Kota Bandung

Kampus

Unpad Kembangkan Riset Perlebahan agar Hutan Letari dan Masyarakat Sejahtera

Sabtu, 21 Juli 2018 19:45

Rektor Unpad, Prof. Dr. med. Tri Hanggono Achmad, saat memaparkan pengantar materi kesehatan dan keberadaan perlebahan, dalam acara Ngopi Sore di Riung Karsa, di Jalan Cisangkuy No 62, Bandung, Jumat (20/7/2018).

Laporan Wartawan Tribun Jabar, Resi Siti Jubaedah

TRIBUNJABAR.ID, BANDUNG - Universitas Padjadjaran mengembangkan penelitian tentang pelebahan di Indonesia.

Tujuannya agar masyarakat paham bagaimana mengembangkan usaha perlebahan secara baik sehingga ekosistem hutan di Indonesia letasi dan kesejahteraan masyarat meningkat.

Ir Yadi Supriyadi, MS salah satu periset Unpad mengatakan, kesehatan dan keberadaan perlebahan merupakan kunci pertanian berkelanjutan di seluruh dunia.

Semakin berkurangnya produksi madu menandakan populasi lebah yang ada di dunia semakin berkurang.

Hal ini mempengaruhi ekosistem lingkungan terutama daerah hutan yang menjadi sumber kehidupan hewan, tumbuhan bahkan manusia.

"Jika ekosistem lingkungan baik, maka lebah juga baik, dalam melestarikan lebah, harus melestarikan hutan sebagai ekosistem yang akan melestarikan lebah," ujar Yadi Supriyadi dalam acara Ngopi Sore di Riung Karsa, di The Sixty Two Resto and Lounge, Jalan Cisangkuy No 62 Bandung, Rabu (20/7/2018).

Selain itu tujuan membudi dayakan lebah, agar masyarakat faham betul akan manfaat dari lebah yang sangat banyak.

Rektor Unpad, Prof. Dr. med. Tri Hanggono Achmad, dr, berharap masyarakat dapat mengkonsumsi lebah yang cukup, tidak hanya pada sebagai obat saja. Baik konsumsi dalam bentuk minuman, maupun makanan ringan dengan kandungan madu.

Sehingga SAMS (Smart Apiculture Management Services) Project memungkinkan para peternak lebah memantau secara aktif kesehatan lebah dan aktivitas lebah dalam sarang melalui pengembangan ICT (Teknologi Informasi dan Komunikasi) yang tepat.

Program riset dan inovasi tersebut menitik beratkan pada penciptaan keunggulan pengetahuan, industri, dan mempersiapkan perubahan sosial di masa yang akan datang.

Sehingga menghasilkan aneka ragam pengetahuan kelas dunia dan membumikan hasil inovasi di tingkan industri dan masyarakat.

Selain itu, diharapkan pada program ini dapat menciptakan lapangan pekerjaan, memicu investasi, dan pertukaran ilmu pengetahuan melalui perluasan jaringan.

Semua hasil riset Unpad akan dikemas dalam program Riung Karsa (Riset Unggulan Unpad dan Kerja Sama Untuk Masyarakat Sejahtera).

Riung Karsa akan menjadi media hasil riset dan inovasi, yang memiliki dampak dan kontribusi bagi masyarakat.

Abstract of UNPAD develops Beekeeping Research for Sustainable Forests and Prosperous Communities

Ir. Yadi Supriyadi, one of the Universitas Padjadjaran researchers, explained that the decrease in honey productivity is one of the effects of the decline in bee colony population caused by deteriorating environmental conditions. Meanwhile, the health and existence of bee colonies is the key to the sustainability of agriculture around the world.

With the decline in the condition of beekeeping in the world, it will cause a decline in the condition of the ecosystem which affects the life of plants, animals and humans.

The Smart Apiculture Management Services (SAMS) research is intended to help beekeepers to be able to actively monitor the condition of their bee colonies in the hive by utilizing the development of appropriate Information, Communication and Technology (ICT).

This research and innovation program focus on creating knowledge excellence, industry, and preparing for future social change. To produce world-class knowledge while still grounding it at the industrial and community levels. In addition, it is also hoped that it can create jobs, trigger investment, and exchange knowledge through network expansion.

1.1.4 July 21,2018 – Detik News – UNPAD explores the Benefits of Bees

detiknews

Home Berita Daerah Internasional detikX Kolom Blak Blakan Pro Kontra In

Adsmart Terpopuler Jawa Barat Jawa Tengah & DIY Jawa Timur Makassar Medan

detikNews > Berita Jawa Barat

Unpad Gali Manfaat Lebah

Mochamad Solehudin - detikNews

Sabtu, 21 Jul 2018 00:24 WIB

0 komentar

SHARE

Kegiatan Riung Karsa di Bandung. (Foto: Mochamad Solehudin/detikcom)

Bandung - Lebah rupanya memiliki banyak manfaat. Salah satunya yaitu untuk mengetahui tolok ukur mutu lingkungan di sebuah wilayah dalam kondisi baik atau tidak.

Peneliti Universitas Padjadjaran (Unpad) Dwi Purnomo menuturkan keberadaan lebah bisa menjadi salah satu pintu masuk dalam pembangunan berkelanjutan. Saat ini pihaknya bersama peneliti Unpad lainnya tengah berupaya mengembangkan berbagai potensi lebah.

Karena menurutnya, banyak manfaat yang bisa diambil dari keberadaan lebah. Tidak hanya madunya saja, kata dia, tapi berbagai manfaatnya lainnya terutama dalam pembangunan berkelanjutan terkait lingkungan.

"Karena jika lebah itu menurun (populasinya) itu faktor kerusakan lingkungan. Rantai manfaatnya tidak hanya madu, tapi dari juga aspek ekonomi, ekologi, pemberdayaan, kelestarian lingkungan. Setidaknya ngomongin lebah dan madu itu menjadi *entry point* untuk pembangunan berkelanjutan," kata Dwi saat acara Riset Unggulan Unpad dan Kerjasama Untuk Masyarkat Sejahtera (Riung Karsa) di The Sixtytwo Cafe, Kota Bandung, Jumat (20/7/2018).

Selain itu dia mengungkapkan, saat ini pihaknya sedang mengembangkan Smart Apiculture Management Services (SAMS). SAMS merupakan proyek riset internasional di bawah program Horizon 2020 ICT-39 Uni Eropa.

"SAMS proyek ini adalah transfer teknologi dari negara Eropa yang sudah berhasil mengembangkan populasi lebah yang bagus, kemudian teknologinya di transfer ke Indonesia," ujarnya.

Namun dalam transfer teknologi tersebut perlu disesuaikan dengan kearifan lokal di Indonesia agar bisa diterima oleh masyarakat. "Terus bukan soal transfer teknologinya tapi juga bagaimana agar bisa bikin *impact* yang luas buat masyarakat," katanya.

Salah satunya melalui pengembangan bisnis melalui potensi lebah dan madu yang dihasilkan. Caranya ialah mengembangkan sejumlah produk-produk seperti minuman yang diproduksi oleh peternak lebah madu.

"Jadi tidak hanya memanfaatkan lebah dan sarangnya, tapi produk-produk turunannya," katanya.

Dosen Fakultas Pertanian Unpad Yadi Supriyadi menambahkan lebah memiliki peran penting dalam masalah kelestarian lingkungan. Sebab, menurut dia, melalui lebah dapat diketahui lingkungan rusak atau tidak.

"Lebah itu jadi tolok ukur mutu lingkungan. Kalau (lebah) menetap lebih lama lokasi (lingkungan) baik. Karena lebah itu tidak diam kalau air tercemar, udara kotor. Kalau (lebah) menetap berarti mutu lingkungan bagus," ujar Yadi.

Riung Karsa

Rektor Unpad Tri Hanggono menjelaskan acara yang diberi nama Riung Karsa ini bertujuan menyosialisasikan berbagai hasil riset yang dilakukar dosen Unpad kepada masyarakat. Karena Unpad ingin hasil riset yang dibuat itu memberi dampak luas bagi masyarakat.

"Kami berkomitmen untuk kemaslahatan masyarakat," ujarnya.

Acara Riung Karsa ini, lanjut dia, akan digelar setiap pekannya. Berbaga produk atau riset dosen Unpad akan dipaparkan melalui acara tersebut.

"Ini akan digelar setiap minggu. Jadi berbagai hal akan dibahas. Tidak hanya menyangkut produk atau riset saja, tapi juga soal kebijakan juga akan dibahas nantinya," ucapnya. **(bbn/bbn)**

Abstract of UNPAD explores the benefits of bees

The kick-off event Riung Karsa is linked to the international research project named Smart Apiculture Management Services (SAMS). This project is focusing on technology development in the apiculture sector which is implemented in Europe and being transferred to Indonesia. However, this technology needs to be adapted to local needs and values to bring broader benefits. In this event, bee benefits were explained by Yadi Priyadi and Dwi Purnomo, researchers of UNPAD. The benefits mentioned are not limited to honey benefits but also other benefits such as bees as environmental indicators to see an environment quality, as an entry point to a sustainable development in economic, ecologic, community empowerment, and environmental sustainability aspects.

1.1.5 July 23,2018 – Pikiran Rakyat – Bees are not merely honey producer

Lebah Bukan Sekadar Penghasil Madu

LEBAH mungkin sudah mulai terlupakan terkait peranan pentingnya dalam ekosistem. Lebah mungkin hanya dikenal sebagai hewan penghasil madu yang kaya nutrisi serta sifat stimulannya yang dapat memperbaiki selera makan, membantu sistem pertahanan tubuh, pembentukan sel darah merah maupun sifat lainnya yang baik bagi kesehatan.

Karena sifatnya inilah, madu memiliki nilai ekonomis yang tinggi. Saat ini menjamur berbagai penganan kontemporer yang menjadikan madu sebagai fokus nilai tambahnya. Meningkatnya permintaan ini madu ini kerap tidak diimbangi peningkatan budi daya lebah di dalam negeri. Hal ini kemudian memunculkan adanya madu impor hingga madu yang dipalsukan.

Lebah tidak bisa dianggap sepele peranannya. Ia sebagai polinator yang paling berperan dalam penyerbukan tanaman di muka bumi. Namun, sayangnya, ditengarai terjadi penurunan jumlah lebah di Indonesia akibat perilaku manusia yang tidak ramah lingkungan. Ini terlihat dari penggunaan pestisida yang berlebihan serta perambahan lahan-lahan untuk kebutuhan hidup manusia.

Padahal, keberadaan lebah dapat menjadi indikator alami untuk mengetahui kondisi alam. Jika di suatu daerah masih terdapat lebah, dapat dikatakan kondisi lingkungan daerah tersebut masih tergolong baik. Ini disebabkan, wilayah tersebut masih banyak tumbuh bunga-bunga dari suatu tanaman yang mengandung nektar dan pollen, dua sumber utama makanan lebah.

Mengenal lebah membawa pada dimensi yang jauh lebih luas. Kendati sebagian masyarakat mengenalnya sebagai penghasil madu atau sengatannya, lebah merupakan salah satu mahkluk hidup yang bisa dijadikan salah satu contoh bijak bagaimana seharusnya manusia meniru karakteristik lebah dalam memenuhi kehidupan dengan tetap mempertimbangkan keberlanjutannya.

"Menjodohkan" lebah dengan teknologi digital menjadi upaya efektif dalam mempromosikan sektor perlebahan sebagai peluang pengembangan teknologi. Ini bisa menjadi salah satu contoh baik dalam menggambarkan kesiapan Indonesia menghadapi era revolusi industri ke-4 di tingkat global.

Saat ini, Universitas Padjadjaran tergabung dalam konsorsium riset internasional bersama Uni Eropa dalam naungan Horizon 2020 bernama Smart Apiculture Managenent System (SAMS) atau Sistem Manajemen Perlebahan Pintar. Proyek riset SAMS akan menyodorkan kebaruan teknologi digital yang akan diterapkan untuk memonitor kesehatan koloni lebah, jelajah lebah hingga produktivitas lebah.

Teknologi yang dikembangkan menggunakan *design thinking/user centered design* yang dilakukan Unpad bersama Primary Indonesia-Labtek Indie sebagai mitra lokal.

Jika orientasi revolusi industri ke-4 didominasi oleh teknologi robotik, analisis *big data*, ICT, dan lainnya, proyek SAMS bisa diarahkan untuk menjadi standar baru revolusi industri. Selain basis teknologi informasi yang dapat dikembangkan, teknologi dan bisnis lebah ini memiliki dampak luas bukan hanya dari sisi ekonomi, tetapi juga menjadi daya dorong perbaikan ekologis.

Berbasis digital

Teknologi SAMS diperkenalkan di Eropa sejak 2008. Teknologi berbasis digital ini merupakan teknologi informasi yang dirancang untuk memantau kondisi koloni lebah yang meliputi kesehatan, distribusi, dan kemajuan koloni lebah yang ditanam. Teknologi ini mampu meringkas data besar untuk memantau kebutuhan pakan lebah yang menunjukkan kesehatan lingkungan sekitarnya.

Penerapan teknologi ini digabungkan dengan model bisnis sosial yang dirancang sesuai konteks lokal Indonesia. Diharapkan, SAMS Project Indonesia dapat mengilustrasikan penerapan revolusi industri 4.0+.

Model bisnis aplikasinya akan dirancang untuk memiliki karakteristik yang unik, yaitu memperluas dampak bagi masyarakat, berorientasi pada manusia, mempertimbangkan aspek budaya lokal, berorientasi pada kearifan lokal, menghasilkan pertumbuhan ekonomi yang baik, fokus pada isu-isu lingkungan dan pembangunan berkelanjutan, serta menghasilkan manfaat secara global.

Peternakan lebah dan bisnis digital dalam perencanaan model SAMS ini diharapkan menjadi contoh yang jelas yang berorientasi pada tujuan pembangunan berkelanjutan (SDGs). Dengan berorientasi pada SDGs, budi daya lebah dapat diperankan sebagai satu titik "akupuntur" untuk memberikan daya dorong kemajuan wilayah yang terjamin keberlanjutannya.

Lebah yang memiliki peran penting dalam proses penyerbukan (polinator) tidak hanya memberikan keuntungan untuk proses polinasi berbagai tanaman. Lebih jauh hasil madunya mampu memberikan daya dorong lain yang mencakup pada 17 aspek SGDs secara nyata dan saling menumbuhkan keterkaitannya.

Mengawinkan teknologi digital dengan inovasi sosial dalam proyek ini jika dirunut lebih tajam, rantai manfaatnya begitu luas. Budi daya lebah berpotensi mengurangi kemiskinan karena mampu menciptakan lapangan kerja baru dan mencegah urbanisasi akibat ketimpangan lapangan pekerjaan di daerah perdesaan. Potensi lainnya yaitu peningkatan mutu hidup dan tingkat kesehatan, perluasan dampak bagi kesetaraan gender, serta peningkatan kualitas lingkungan.

Manfaat sektor perlebahan juga berpengaruh pada ketersediaan air yang terjaga. Ini didasarkan budi daya lebah akan otomatis menjaga kelestarian hutan. Di bidang riset dan pembelajaran, sektor perlebahan dapat dapat menjadi media pembelajaran transformatif baru.

Lebah, dunia digital dan inovasi sosial tampaknya menjadi satu contoh nyata adanya integrasi riset yang mampu melampaui target di revolusi industri tahap 4. Dengan karakteristiknya yang unik, model bisnis lebah berpeluang membawa dampak baik secara sosial, ekonomi maupun ekologis secara masif dan menjadi lokomotif pembangunan berkelanjutan.

Di masa yang akan datang, perlu lebih banyak lagi riset yang diselenggarakan dengan mengutamakan kolaborasi antarkeilmuan, melibatkan berbagai pemangku kepentingan, serta memberikan dampak nyata bagi masyarakat secara luas. Penerapannya di masyarakat tentunya akan menjadi sumber bagi ilmu dan pengetahuan baru yang dapat dipergunakan sebaik-baiknya bagi kesejahteraan dan kelestarian lingkungan hidup. (**Dwi Purnomo**, *peneliti dan dosen dari Fakultas Teknologi Industri Pertanian Unpad sekaligus Ketua Tim Riset Unpad untuk SAMS Project Indonesia-Horison 2020*/**Marlis Nawawi**, *alumnus Magister Ilmu Peternakan Fakultas Peternakan Unpad*)***

MADU yang dihasilkan lebah tidak hanya dikonsumsi sebagai bahan pendukung kuliner. Sekarang madu dimanfaatkan juga untuk bahan dasar produk-produk kecantikan.

FOTO: HUMAS UNPAD

Bees are not merely honey producer

Many people, perhaps, are starting to forget the role of bees in our ecosystem. At the beginning, bees were known only for their honey which is widely known as a nutrition-rich food ingredient and its stimulant element, which is good for increasing appetite, helping body immune system, creating red cell blood, and its other advantageous effects which are good for health. Because of these advantages, honey is considered to have high economical value. Even at present, there have been many contemporary comestibles featuring honey as their strong value. However, the demand of honey that is on increase and not balanced with the improvement of bee cultivation are causing fake honey products to emerge and it significantly raises the import of honey. As honey is discussed, the honey creator, bee, should not be forgotten.

The role of bee, as a pollinator, cannot be underestimated as it contributes the most in pollinating plants. It is suspected that, in Indonesia, the number of bees is decreasing as the result of environmentally unfriendly behavior of human, especially the excessive use of pesticide in agriculture and the encroachment by human on lands, which are the source of human food. The existence of bees can also be an indicator of nature condition. If in a region, the number of bees is significant, it can be said that the nature condition of that region is fine. The reason is there is still an enough source of bee food, nectar and pollen, which are created by a flower of a plant.

During the last five years, UNPAD has been actively conducting social innovation research in Social Entrepreneurship activities. In addition to that, at this moment, UNPAD is also actively activating topics related to digital business. These two aspects are the strength of UNPAD research at this time, where Padjadjaran University is incorporated in a joint European Union International research consortium under the Horizon 2020 umbrella called the Smart Apiculture Management System (SAMS) or Smart Beekeeping Management System. The SAMS research project will offer digital technology that will be applied to monitor the health of bee colonies, monitor bee roaming and bee productivity. This technology is still in the research stage by using UNPAD Design Thinking / User Centered Design approach together with Primary Indonesia and Labtek Indie as local partners. Information Technology Development aimed at bee monitoring aspects was developed through research on business models for honey bee industry development to expand its social impact.

Combining Digital Technology with Bees can be one good example that illustrates that it is time that we go beyond the 4th industrial revolution. If the orientation of the 4th industrial revolution is dominated by robotic technology, Big Data Analysis, ICT and others, SAMS can be directed to become a new standard of the industrial revolution where, in addition to the basis of information technology that can be developed, the bee technology and business have a broad impact not only on the side economy, but also it can be the driving force for ecological improvement.

If the Industrial Revolution (RI) 4.0 is closely related to the digital integration of information technology and physical systems, RI 4.0 generally integrates various roles of large data, robotic systems, intellectual intelligence, and connectivity that do not need to be limited. Bee cultivation, the RI 4.0+ objects, will be tested as research objects. Bee cultivation is closely related to environmental ecosystems and can be an attractive factor for an environmentally oriented and sustainable industry. Smart Apiculture Management Services (SAMS) technology was introduced in Europe since 2008 through ITAPIC Technology. SAMS is a digital-based technology, information technology designed to be able to monitor the condition of bee colonies which include the health, distribution, and progress of planted bee colonies. This technology can summarize large data to monitor the needs of bee feed which shows the health of the surrounding environment.

The application of this technology is combined with the Social Business Model designed in accordance with the local context of Indonesia. Then, it is expected that the SAMS Project Indonesia can illustrate the application of the Industry 4.0+ Revolution. The application business model will be designed to have unique characteristics; 1) expands the impact for the community, 2) human-oriented, 3) considers aspects of local culture, 4) oriented to local wisdom, 5) produces good economic growth, 6) focuses on environmental issues and sustainable development and 7) global impact. Beekeeping and Digital Business in the planning of the SAMS model are expected to become clear examples that are oriented towards sustainable development.

Speaking of sustainable development goals (SDGs) where a model does not only look at economic, social and environmental issues separately, but also sees a comprehensive multi-faceted connection, Beekeeping can be played as a single point of "acupuncture" to provide the impetus for the progress of the region that is guaranteed its sustainability. Bees that have a very important role in pollination (pollinator) processes not only provide benefits for the process of pollination of various crops both agricultural crops, plantations and forest plants. However, further results of the honey can provide other impetus to the 17 aspects of SGDs in real terms and to foster interrelationships.

Bringing together digital technology with social innovation in the container of bees, if traced more deeply, the chain of the benefits is so large. The benefits begin with the aim of reducing poverty because it is able to create new jobs, especially to prevent urbanization due to lack of employment in rural / inland areas, improvement of quality of life and level of health, expansion of impacts on gender equality, improvement of environmental quality because the community is made to be aware that maintained environment will secure reserves of bee food so that honey can continue to be harvested. Furthermore, the benefits will have an impact on water availability because forests are maintained, narrowing social gaps to aspects of research and learning because they can be used as new transformative learning media. The advances that are expected to be obtained from this massive and systematic re-activation of beekeeping are the presence of real sustainable development goals in the community. With the points of "acupuncture" in the form of scattered bee colonies will have a wide impact on the 17 goals of SDGs.

Bees, the digital world and social innovation seem to be a real example where integrated research activities can go beyond merely being in industry 4.0. With its unique characteristics, this bee business model can have an impact socially, economically and ecologically massive and become a locomotive for sustainable development. In the future, more research needs to be carried out by prioritizing collaboration between sciences, involving various stakeholders and giving a real impact to society at large. Its application in the community will certainly be a source of new knowledge and knowledge that can be used as well as possible for the welfare and preservation of the environment.

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1.1.6 July 23, 2018 – Pikiran Rakyat – Encouraging Real Impact of Research for the Community


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Mendorong Dampak Nyata Riset bagi Masyarakat

RISET sejatinya memberikan dampak kemajuan bagi masyarakat. Riset yang berhasil adalah riset yang memiliki jejak kemajuan pada setiap langkah kematangannya. Semakin dalam riset dilakukan, semakin luas pula manfaat yang dirasakan masyarakat dan tentunya semakin terjaga keberlanjutannya.

Encouraging the Real Impact of Research on the Community

(Learning from the International Bee Research Consortium of SAMS Project Horizon 2020 EU)

Research actually has an impact on society. Successful research is a research that has a track of progress at each step of maturity. The more research is carried out, the more broadly the benefits are felt by the community and, of course, the more sustained its sustainability.

To build the good goals of research, it is necessary to do so with the intention to bring benefits to mankind. Providing the best contribution to the community can be in the form of academic products which are already tested for validity. For that reason, a good process can be seen from the serious implementation with proven scientific methods, which certainly not only produces quality scientific publications, but also brings the impact of progress on human civilization.

Why does this paper begin by discussing the sincerity to bring about a good impact and process? In order to do so, the researchers do not experience errors in distinguishing goals from consequences, for example, when high scientific publications become a measure of success. It should be emphasized again that the purpose of research is to bring benefit. The success of scientific publications will be a consequence because researchers carry out the process seriously and write the process and results well. The good intention and the serious process of research are truly the main capital of a research. A good recorded process will provide portfolios that bring an impact in the community and produce various forms of collaboration enriching the process and the results of research.

To get a rich research process, cooperation in a research involving different scholarships is necessary. Likewise, cooperation with various institutions, it is important to do so that it can provide access to the resources to achieve a shared vision. Cooperation with a variety of multi-sector institutions brings an open research process to new ideas and methods. Various kinds of input can be a source of deeper understanding of the context of the problem being sought to be collaborated. Speaking of cooperation on paper is easy but carrying out a good cooperation needs to have a good process so that the capacity of its human resources will gradually become superior and are able to be good collaborators for the institution.

Obtaining an international cooperation, expanding the impact of research and gaining resources from internationally reputable institutions are actually a description of a system and process that is built in earnest, especially if you want to have a strong and continuous attachment to maintain good relations, improve the quality and exchange the resources to achieve the vision of the future.

To build a research collaboration, especially cooperation on a large scale needs to be prepared with frequent cooperation programs starting with practicing organizing an internal scope with different scientific backgrounds, and consistently trying to go up to the next level with the cooperative skills that have been owned. A research that is carried out in small or large scale, short or long term is actually a valuable learning process of mastering cooperative skills. These skills include communication, administration, resilience, the ability to produce impacts and other matters concerning aspects of professionalism.

Good cooperation can also be realized because the researchers are consistent in their fields, and they are able to present their specific abilities to enrich the context of research conducted by their partners, and so as the cooperation partners should not only complement the research with his/her own abilities, but also create a good process to exchange resources without compromising the vision of the organization that is carried. In general, every organization that has the intention to collaborate has a different vision. Therefore, what needs to be explored is an object that can be done together so that they can meet the resources needed to strengthen and accelerate the achievement of its vision. Cooperation partners who can exchange resources without spending excessive fees can then be classified as key partners.

Learning from the SAMS Project

The SAMS Project is a research consortium involving European countries and developing countries that choose ICT and Beekeeping as the object of their research. Involving various international, national and regional institutions is not something that is feared since it seems to be complicated and difficult. The basic philosophy of involvement is that the richer the collaboration, the richer the input and process will be. For this reason, collaboration is carried out by laying out clear foundations regarding the scope of roles to be collaborated. Although related to bees, there were eleven different faculties at Padjadjaran University, actively involved in developing their research, namely 1) Agricultural Industry Technology, 2) Agriculture, 3) Social and Political Sciences, 4) Fisheries and Marine Sciences, 5) Communication, 6) Economics and Business, 7) Cultural Sciences, 8) Nursing, 9) Pharmacy, 10) Animal Husbandry and 11) Law. It can be imagined that with these eleven different sciences, the beekeeping context can be explored with an extraordinary richness. New ideas come out and bring optimism to be able to apply the research and to have a broad impact on society and science itself.

The context of cooperation cannot be done only from academics. Therefore, the context of Pentahelix's collaboration involving Academic, Business, Government, Community and Media is clearly illustrated in this research collaboration. Academic role is to provide a scientific point of view so that the process goes through a valid process. The SAMS Project also embraces businessmen from large to small scale. Businesspeople provide an important point of view where a research must also generate profits so that sustainability can be maintained. Another important party is the Government. The government is invited to speak and explore its point of view, looking for a chance where this research content can fill government policy. For example, in the government policy of West Java Province with its 10 Common Goals, SAMS can fill priority content in three goals in the field of 1) Agricultural Economy, 2) Poverty Alleviation, PMKS and Security, and 3) the management of Environment and Disaster. The government is not always asked to provide funds, but, more importantly, the government is invited to become a key partner in the field of development priorities and to provide opportunities for researchers to fill their content.

The third partnership is the community. The community is the easiest one for cooperation because in general it is free from bureaucratic difficulties. The community is the most militant party to cooperate because it is driven by its passion. A community with more youth turns out to be more aggressive because it has a clearer dream of the impact on the community through the fields which they fight for. The community involved in this collaboration is the Common Room Network which has become an international collaborator, with high desire to make the best contribution to the development of indigenous knowledge. The Local Enablers has high energy to spread benefits through Social Entrepreneurship and Labtek Indie, a group of young people who enthusiastically provide their best work through information technology. It is this community that gives a firm color to the presence of research in the community.

The last pillar is the media. The media is the party needed to become a research amplifier which then can be written simply in the community, to make it easy to replicate or just to be an inspiration. The last two pillars of cooperation are often forgotten, namely the younger generation community and the media which are the right pair to become impact drivers and amplifiers. Being a funnel of change and bringing an innovation are not just a breath of fresh air, but it is like wind that flies the superior seeds to be brought and earthed in new lands and to give birth to new sources of life.

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1.1.7 July 23, 2018 – Pikiran Rakyat – Processed Honey; Added Value for Sustainability

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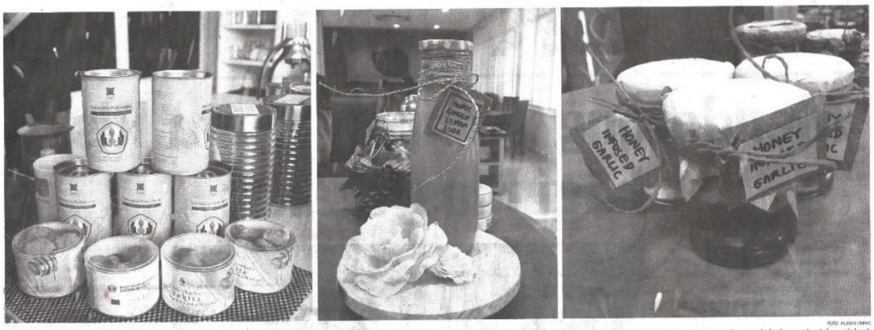

FOTO: HUMAS UNPAD

*BUDI daya lebah kini lagi digiatkan seiring dengan meningkatnya permintaan madu. Seperti diketahui, madu kaya akan nutrisi serta sifat stimulannya yang dapat memperbaiki selera makan, membantu sistem pertahanan tubuh, dan pembentukan sel darah merah.**

Olahan Madu, Nilai Tambah bagi Penjaga Kelestarian

MADU dikenal sebagai komoditas populer yang memiliki khasiat baik untuk tubuh manusia. Masyarakat pada umumnya masih mengonsumsi madu dalam bentuk aslinya tanpa mengalami penanganan dan pengolahan lebih lanjut menjadi produk turunan bernilai tambah.

DI era saat ini semakin marak produk kuliner serta produk kecantikan bagi wanita yang dijual di pasaran dengan bahan baku dari madu. Hal ini menunjukkan madu masih diminati masyarakat Indonesia.

Sebagian besar kandungan madu ialah karbohidrat dalam bentuk fruktosa dan glukosa. Selain itu, juga terdapat air, asam amino, enzim, polifenol, mineral, dan vitamin. Kadar air madu yang cukup rendah serta adanya senyawa antibakteri menyebabkan madu dapat disimpan dalam waktu yang relatif lama.

Madu dikonsumsi oleh masyarakat demi khasiat yang diberikannya terutama bagi kesehatan karena memiliki nutrisi tinggi, aktivitas antibakteri, mengandung vitamin dan mineral tinggi, baik dalam menanggulangi penyakit flu, radang tenggorokan, dapat mengobati luka bakar, menjaga kesehatan kulit dan bibir, maupun menjaga stamina dan kesehatan bagi seluruh golongan usia. Bergantung pada jenis produk turunan dan intensitas pengolahannya, sekian banyak khasiat madu tersebut masih dapat dijaga jika diolah dengan baik dan benar.

Khasiat madu memang akan diperoleh dengan maksimal jika madu dikonsumsi dalam bentuk aslinya, tetapi untuk memenuhi kebutuhan bisnis di mana profit dapat diperoleh karena nilai tambahnya tinggi, madu dapat diturunkan produknya.

Era bisnis kontemporer saat ini perlu dieksplorasi berbagai pengalaman dari sebuah komoditas, termasuk madu. Madu dapat diolah menjadi berbagai macam penganan turunan, bahan baku kecantikan atau produk lainnya. Selain bernilai tambah, jika keterampilan ini ditularkan pada para peternak lebah dan keluarganya, tentunya akan menjadi wadah pemberdayaan yang baik untuk membawanya pada tingkat kesejahteraan yang lebih baik.

Madu dapat diolah menjadi berbagai jenis produk, baik sebagai produk pangan, kesehatan maupun produk kecantikan untuk perawatan wajah dan tubuh. Seperti yang telah disebutkan sebelumnya, produk akhir madu dengan sifat yang serupa dengan madu aslinya akan masih memiliki seluruh khasiat madu, tetapi jika madu telah mengalami serangkaian proses pengolahan seperti pemanasan terutama di atas 60-80o C, sebagian besar khasiat, aktivitas, dan sifat madu akan mulai berubah atau hilang.

Madu dengan kualitas yang tinggi cocok untuk dijual dalam bentuk produk-produk madu dengan karakteristik yang tidak terlalu jauh dengan madu asalnya. Sementara itu, madu dengan kualitas apa pun dapat diolah menjadi berbagai produk olahan madu dengan intensitas proses pengolahan yang tinggi terutamanya sebagai pengganti gula tebu dan pemberi flavor khas madu pada produk yang dibuat. Di sinilah terbuka peluang-peluang ekonomi untuk meningkatkan utulitas turunan madu dari berbagai mutunya.

Warna gelap

Jenis dan komposisi madu sangat bervariasi di antaranya bergantung pada nutrisi dan jenis makanan yang dikonsumsi oleh lebah sebagai bahan dasar pembentukan madu. Sebagai contoh, madu hutan memiliki warna cokelat agak hitam. Ini disebabkan kandungan mineral dan enzim madu hutan lebih lengkap daripada madu yang dipanen dari tempat selain hutan.

Warna madu yang gelap akan memengaruhi warna dan kenampakan produk akhir yang dibuat. Madu juga mengandung karbohidrat yang tinggi sehingga selain sebagai sumber energi yang baik, tingkat kemanisan serta sifat-sifat karbohidrat dalam pengolahan juga berlaku sehingga dapat memengaruhi tekstur, kenampakan dan rasa dari produk yang dihasilkan. Keseluruhan faktor ini akan memengaruhi cara pengaturan formulasi bahan-bahan yang digunakan untuk menghasilkan produk olahan yang diinginkan.

Banyak produk pangan yang dapat dibuat dengan karakteristik madu yang masih segar untuk dicampurkan langsung dengan berbagai pengenan. Ada 15 produk olahan madu yang telah dikembangkan Unpad di antaranya Honey Butter, Honey Lip Scrub, Honey Hydrating Sheet Mask, Honey Infused Lemon Ginger, Honey Infused Garlic, Honey Balls, Honey Nut Paste, Honey Cookies, Honey Sauce, Honey Nougat, White Chocolate and Honey Mousse, Honey Yoghurt Mint Sauce, Honey Ginger Lemon Soda, Banana Yoghurt Peanut Butter Smoothie, dan Honey Espresso Three Way serta olahan kontemporer lainnya.

Sementara itu, penggunaan madu untuk produk perawatan tubuh dapat dijadikan *scrub* wajah, sabun pencuci muka, pembersih kulit, dan lainnya. Teknologi pengolahan yang digunakan cukup sederhana dan dapat dilakukan pada skala rumah tangga. Dengan menggunakan bahan dan peralatan pengolahan yang umum digunakan, transfer teknologi dan prosedur pengolahannya pada masyarakat cukup mudah untuk dilakukan.

Untuk menghasilkan produk turunan madu yang unggul, diperlukan beberapa percobaan untuk sampai pada hasil yang diinginkan. Dari beberapa formulasi produk tersebut, perlu melewati beberapa tahapan uji coba hingga akhirnya merujuk satu formulasi yang memuaskan.

Selain berinovasi dengan produk berbahan dasar madu, riset berikutnya adalah menemukan metode untuk mendiseminasikan hasil riset kepada pembudi daya maupun masyarakat. Ini bertujuan meningkatkan nilai tambah dalam produknya serta membangun kesejahteraan para peternak lebah. Tidak sampai di situ, upaya pengembengan produk ini pun diteruskaan hingga ditemukan model bisnisnya yang tervalidasi sehingga mampu sampai kepada target konsumen yang sesuai.

Untuk pengembangan bisnis yang berkelanjutan dari olahan madu ini, tentunya perlu kolaborasi bersama, terutama mau dan berupaya bersinergi dengan para peternak lebah dan istri peternak lebah atau para wanita yang tinggal di daerah. Pada akhirnya dapat mendatangkan kesejahteraan dengan membuka peluang lowongan perkerjaan baru dengan bisnis yang menjanjikan di dalam perkembangan industri madu di Indonesia.

Produk olahan dan diseminasi keterampilan olahan serta pengembangan bisnisnya ini merupakan daya tarik nilai tambah, bukan sekadar memberikan keuntungan ekonomis bagi produsennya. Jika keterampilan ini didiseminasikan bagi para peternak dan dibangun model bisnis uniknya bersama para pemuda, bukan tidak mungkin olahan madu akan menjadi lokomotif kelestarian lingkungan. (**Rusky Intan Pratama**, *peneliti dan dosen Laboratorium Pengolahan Fakultas dan Ilmu Kelautan Universitas Padjadjaran. Anggota Tim Penelitian Konsorsium SAMS Project Horison 2020*/**Linda Hindasah dan Ina Sawitri**, *alumnus Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran*)***

The Processed Products of Honey; Added Value for Keeping Sustainability

The views of the Indonesian people regarding honey may no longer be doubted. Honey is known as a popular commodity with properties that are good for the human body. People still consume honey in its original form without experiencing further treatment and processing into value-added derivative products. However, in the current era, more and more beverage products, food and beauty products for women sold in the market are made of honey as either raw materials or additives. It can be concluded that honey still has an attraction in Indonesian market.

Most of the honey content is carbohydrates in the form of fructose and glucose. Besides there are also water, amino acids, enzymes, polyphenols, minerals and vitamins. The low level of honey water and the presence of antibacterial compounds cause honey to be stored in a relatively long time. Honey is consumed by the community due to its benefits, especially for health since it has high nutrition, antibacterial activity, high vitamins and minerals, and is good in dealing with flu, sore throat. It can also treat burns, maintain healthy skin and lips, and maintain stamina and health for all ages. Depending on the type of derivative product, and the intensity of the processing, many of the benefits of honey can still be maintained if processed properly and correctly.

The benefits of honey will be obtained maximally if honey is consumed in its original form. However, to meet business needs where profit can be obtained because of its high added value, honey can be derived by its products. Today's contemporary business era needs to explore various experiences of a commodity, including honey. Honey can be processed into various kinds of derivative foods, beauty raw materials or other products. Besides being added value, if this skill is transmitted to beekeepers and their families, it will certainly be a good empowerment to bring it to a better level of welfare.

Honey can be processed into various types of products, such as food products, health and beauty products for facial and body care. As mentioned earlier, the honey product with the similar properties to the original honey will still have all the properties of honey. However, if honey has undergone a series of processing processes such as heating especially above 60-80^{o}C, then most of the benefits, activities and properties of honey will begin to change or lost. High quality of honey is suitable for sale in the form of honey products with the characteristics that are not too different from the original honey, while any quality of honey can be processed into various processed products of honey with high processing intensity, especially as a substitute for cane sugar and a honey flavor on the processed products. This is where economic opportunities open to increase the derivative of honey from various qualities.

Choosing honey for its derivative products

The type and composition of honey vary greatly depending on nutrition and the type of food consumed by bees as a basic ingredient in honey formation. For example, forest honey has a rather dark brown color since it consumes a more complete mineral and enzyme content than do other honeys harvested from places other than forests. The dark color of honey will affect the color and appearance of the final product of honey. Honey also contains high carbohydrates so that besides being a good source of energy, the level of sweetness and properties of carbohydrates in processing can affect the texture, appearance and taste of the products produced. All these factors will affect the way in which the formulation of ingredients is used to produce the processed product.

Many food products can be made with the characteristics of fresh honey to be mixed directly with various ingredients. The processed food products that can be made with honey as either a main ingredient or a mixture can be seen from 15 products that have been developed by UNPAD including: *Honey Butter, Honey Lip Scrub, Honey Hydrating Sheet Mask, Honey Infused Lemon Ginger, Honey Infused Garlic, Honey Balls, Honey Nut Paste , Honey Cookies, Honey Sauce, Honey Nougat, White Chocolate and Honey Mousse, Honey Mint Yogurt Sauce, Honey Ginger Lemon Soda, Banana Yoghurt Peanut Butter Smoothies, Honey Espresso Three Way* and other contemporary products. In addition, the use of honey for body care products can be used as facial scrubs, facial wash soaps, skin cleansers and more. The processing technology used is quite simple and can be done on a household scale using materials and processing equipment that are commonly found and easy to use so that the transfer of technology and processing procedures to the community is quite easy to do.

The Dissemination of Skills and The Development of Business Model for Processed Honey

To produce superior derivative products of honey, several experiments are needed to arrive at the desired results. There are many challenges that must be faced. From some of the product formulations it is necessary to go through several stages of trial until finally referring to one satisfactory formulation.

In addition to innovating with honey-based products, the next research is at the stage of how to train these skills to bee farmers and their families to increase the added value in their products and to build the welfare of beekeepers so that these beekeepers have a great desire for increasing the productivity of bee livestock and are economically able to have an impact on their economy. Besides, the effort to develop this product is also investigated until it found a validated business model that can reach the appropriate target of consumers.

For the development of sustainable business from these honey products, of course, it needs a collaboration, especially willing and trying to synergize with beekeepers and their wives or the women who live in the area. In the end it can bring prosperity by opening opportunities for new jobs with promising businesses in the development of the honey industry in Indonesia.

These honey products, the dissemination of skills and the business development are an attraction of added value, not just providing economic benefits to the producers. If these skills are disseminated to farmers and their unique business models are built together with young people, it is not impossible that honey products will become a locomotive for sustainability environment. It happens because honey products are proven to be able to help the economy, the end of which is how to preserve nature as a habitat for bees to produce good and continuous bee feed sources and produce honey products themselves.

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1.1.8 July 23, 2018 – Pikiran Rakyat – Learning from Honey Bees

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Pembelajaran dari Lebah Madu

UNIVERSITAS Padjadjaran saat ini tergabung dalam konsorsium Smart Apiculture Management Services (SAMS) Project adalah ikhtiar internasional yang bertujuan mendukung proses adopsi teknologi monitoring koloni lebah madu bagi negara berkembang, khususnya di Etiopia dan Indonesia.

Lessons from Honey Bees

The *Smart Apiculture Management Services* (SAMS) Project is an international endeavor that aims to support the adoption process of monitoring technology of honey bee colony for developing countries, especially in Ethiopia and Indonesia. This project is initiated by an international consortium consisting of the German Development Cooperation (GIZ) GmbH (Germany), University of Kassel (Germany), Latvia University of Life Sciences and Technologies (Latvia), University of Graz (Austria), University of Padjadjaran (Indonesia), Primary Indonesia (Indonesia), Oromia Agricultural Research Institute (Ethiopia), and ICEADDIS (Ethiopia). This project has received funding from the European Union´s Horizon 2020 research and innovation program under the GA 870755.

The development of the technology of bee colony sensor has been done for decades in various parts of the world including in Europe. This is mainly triggered by the phenomenon of shrinking the number of bee colonies known as *Colony Collapse Disorder* (CCD). In various studies several alleged causes of the CCD phenomenon were found, including competition among species, virus and lice disturbances, the effect of electromagnetic waves, climate change, and excessive use of chemical pesticides mainly due to the components of pesticides containing neonicotinoids. The CCD phenomenon is now considered as a trend that endangers the environment globally because it can result in a decrease in the production of various agricultural commodities that can cause disruption of the supply of food sources, in addition to the overall environmental damage.

The adoption of honey bee colony sensor technology in the SAMS project is expected to help honey bee farmers and breeders to find out the health condition of the colony through the use of information and communication technology (ICT) and digital media. Through the process of adopting and utilizing SAMS technology, honey bee farmers and breeders are expected to know in detail the health condition and development of bee colonies, so as to be able to make decisions that can support the health of the colony to increase the honey productivity and maintain the quality of the local environment. In this case honey bees are seen as an integral part of the environmental ecosystem chain that helps the pollination of agricultural crops and forest vegetation, which in the process can also improve the welfare of farmers, cultivators, and beekeepers through the production of honey and all derivative products. In addition, honey bees are also intelligent insects that have the ability to scan the condition and quality of environment *(bio-sensing)*. Honey bee colonies will be difficult to develop in an damaged and polluted environment.

As a first step, the implementation of the SAMS project in Indonesia will be temporarily focused in the scope of the cultivation of *Apis Cerana* honey bee which is a local honey species spread in various regions in Indonesia. *Apis Cerana* bees are are the most maintained bee by honey bee farmers and breeders in Indonesia because they have better durability and adaptability to environmental condition when compared to *Apis Mellifera* species which is imported into Indonesia from Europe. In addition to the *Apis Cerana* and *Apis Mellifera* species, today in some parts of Indonesia there is also the activity of the cultivation of *Trigona* bee which is often called a stingless bee. *Trigona* bees are known as species that produce unique honey characters, in addition to propolis which is widely used for the main components of health supplement products. Apart from some of the types of bees mentioned above, in Indonesia there is also *Apis Dorsata* species which is known as a forest honey producer. This species of bee lives naturally in the forest environment and cannot be cultivated until now.

Given the importance of the position of bee colonies in various dimensions of life, the SAMS planning and implementation process are generally carried out with a *multi-stakeholder* approach, which involves government agencies, the academic world, the business sector, and the community of honey beekeepers and farmers. In Indonesia the SAMS project is carried out by involving stakeholders of bee cultivation and honey production, including the Indonesian Beekeeping Association, the National Beekeeping Center, the West Java Forestry Service, Perhutani Public Corporation, and beekeepers and farmers, some of whom were the members of Forest Village Community Institute. In the first phase, the process of preparing and implementing the SAMS project in Indonesia is temporarily developed in several areas of West Java, including Majalengka, Ciwidey, Bandung and Sukabumi regions. In addition, the SAMS project also involves actors and practitioners who are involved in the development of honey-derived products, especially those engaged in small and medium enterprises (SMEs).

The SAMS project was officially initiated in the end of 2017 and will be implemented until 2020. In Indonesia this project will be carried out jointly by teams from Padjadjaran University and Primary Indonesia. Through collaborations developed jointly, the SAMS project in Indonesia is expected to carry out the adoption process of bee colony sensor technology while developing a business model that places SAMS technology in the ecosystem of bee cultivation and honey business. In this case, the implementation of the SAMS project in Indonesia begins with an effort to gather information and establish a cross-stakeholder network as an effort to get an initial picture and to map the existing beekeeping world ecosystem. This approach also attempts to identify various techniques and local knowledge related to beekeeping activities in Indonesia. With a cross-stakeholder collaboration approach and interdisciplinary work, the adoption process of SAMS technology in Indonesia is expected to increase the productivity of honey bee keepers and farmers, in addition to increasing the enthusiasm of SMEs in the field of beekeeping and honey derivative products.

In the process the SAMS project also involves practitioners, researchers and academics who have diverse backgrounds, especially those who are involved in the world of beekeeping, agriculture, forestry, environment, climate change, and the use of ICTs and digital media. Through the efforts of adopting, developing, and utilizing the bee colony sensor technology, the SAMS project is also expected to assist in the collection of data and information enriching the knowledge of environmental condition in a broad understanding. In this context, the SAMS project is also expected to enrich knowledge regarding efforts to maintain food security and the process of adoption and anticipation of climate change. On the other hand, the various collected data and information are also expected to affect the process of structuring environmental governance policies, especially in agriculture and forestry. In a broad scope, the SAMS project is principally endeavored to have an economic impact and welfare improvement that go hand in hand with effort to maintain environmental condition in a sustainable manner.

Ir. Yadi Supriadi, MP. *(Lecturer at the Faculty of Agriculture UNPAD, member of the SAMS Project team)*

Gustaff H. Iskandar *(Director of Common Room, SAMS Project Advisory Member)*

1.1.9 July 23,2018 – Pikiran Rakyat – Unpad Launches Riung Karsa

ADE BAYU INDRA/"PR"

REKTOR Universitas Padjadjaran Tri Hanggono (kanan) didampingi dua periset sebagai narasumber, Dwi Purnomo dan Yadi Supriyadi, memaparkan pandangannya pada diskusi Riset Unggulan Unpad dan Kerja Sama untuk Masyarakat Sejahtera (Riung Karsa) di Kafe Sixty Rwo, Jalan Cisangkuy, Kota Bandung, Jumat (20/7/2018). Acara tersebut untuk menyosialisasikan dan mempromosikan produk-produk hasil riset unggulan yang dihasilkan peneliti Unpad.

Unpad Meluncurkan Riung Karsa

Upaya Membumikan Hasil Riset bagi Kemaslahatan Publik

BANDUNG, (PR).- Universitas Padjadjaran (Unpad) meluncurkan program Riset Unggulan dan Kerja Sama untuk Masyarakat Sejahtera atau Riung Karsa. Program yang direncanakan digelar berkala (serial) setiap akhir pekan ini diharapkan menjadi rintisan nyata dan aktual membumikan hasil-hasil riset unggulan Unpad sehingga berkontribusi bagi kemaslahatan masyarakat.

Pekan pertama peluncuran Riung Karsa dihadiri langsung Rektor Unpad Tri Hanggono Achmad di Kafe Sixty Two, Jalan Cisangkuy, Kota Bandung, Jumat (20/7/2018). Dalam bincang santai di hadapan media, Tri didampingi Wakil Rektor Bidang Riset, Pengabdian pada Masyarakat, Kerja Sama, dan Korporasi Akademik Keri Lestari serta dua periset sebagai narasumber yakni Dwi Purnomo dan Yadi Supriyadi. Hasil riset pertama yang disampaikan adalah tentang lebah yang menjadi indikator pelestarian lingkungan serta budi daya dan beragam olahan produk yang dapat dimanfaatkan.

"Riung Karsa diharapkan menjadi wahana bagi Unpad untuk mengundang kolaborasi yang lebih banyak dengan masyarakat luas untuk bersama menghasilkan kemaslahatan bersama. Kami berharap hasil-hasil riset dari para peneliti Unpad semakin beresonansi dan menimbulkan dampak nyata bagi kesejahteraan masyarakat," ungkap Tri Hanggo Achmad.

Ia mengatakan, saat ini perguruan tinggi harus melakukan dinamika baru sebagai *knowledge hub*, dengan membangun kolaborasi kuat dengan berbagai pemangku kepentingan. "Hal ini konsisten dengan pandangan Unpad yang sejak dulu menyadari bahwa hasil-hasil kegiatan Tridharma Perguruan Tinggi hanya akan menjadi produk 'menara gading' jika dalam pemilihan gagasan dan proses kegiatan tersebut tidak melibatkan perspektif dan kepentingan unsur-unsur lainnya," ujarnya.

Pentahelix

Menurut Tri Hanggono Achmad, sebelumnya publik mengenal istilah *triplehelix* yakni kerja sama antara dunia akademis, dunia usaha, dan pemerintah. "Namun, di atas semuanya, kampus perguruan tinggi yang juga memiliki tanggung jawab sosial kemasyarakatan, memperluas cakupan kerja sama dalam konsep *pentahelix*. Muara dari itu semua adalah kemaslahatan masyarakat. Jargon yang kemudian harus kita wujudkan terus-menerus adalah Unpad from West Java for Indonesia to the world," katanya menguraikan.

Lebih lanjut, rektor mengungkapkan, kerja sama *pentahelix* ini dilakukan untuk mewujudkan Unpad sebagai *transformative university*. "Ciri utamanya adalah semua hal yang dilaksanakan Unpad dapat memberikan dampak pembangunan kepada masyarakat serta membangun kerja sama interdependensi dengan berbagai pihak. Tidak mungkin kami mewujudkan konteks memberikan maslahat kepada masyarakat tanpa kolaborasi kuat dengan berbagai pemangku kepentingan," ucapnya.

Sementara itu, Keri Lestari menjelaskan, Riung Karsa akan digelar secara serial dengan berbagai sosialisasi dan promosi produk-produk riset, baik dalam bentuk fisik maupun kebijakan berupa regulasi atau *social engineering* lainnya. "Minggu depan akan ada pemaparan hasil riset tentang kemaritiman. Tidak hanya dari aspek perikanan atau riset fisiknya. Riung Karsa ini diharapkan menjadi media *branding* hasil riset dan inovasi yang memiliki dampak dan kontribusi bagi masyarakat luas," katanya. **(Erwin Kustiman)*****

Ulasan Lengkap Riset di Lembar Selisik Halaman 19 s.d 21

Abstract of Unpad Launches Riung Karsa a

Riung Karsa's activities - its first topic the SAMS Project. Universitas Padjadjaran launched UNPAD Flagship Research and Collaboration for a Prosperous Society or Riung Karsa. The program, which is planned to be held periodically (serial) every weekend, is expected to be a real and actual pilot to ground contributing to the benefit of the community.

The first week of the launch of Riung Karsa was attended directly by the Rector of UNPAD, Tri Hanggono Ahmad, at the Sixty-Two Café, Jalan Cisangkuy, Bandung City, Friday (20/07/2018). In a casual conversation in front of the media, Tri was accompanied by the Vice Chancellor for Research, Community Service, Cooperation and Academic Corporations, Keri Lestari, and two researchers as resource persons, Dwi Purnomo and Yadi Supriyadi. Dwi Purnomo, member of the SAMS project team, talked about the importance of bees, in relation to environmental preservation and cultivation and related bee products.

Ngopi Sore di Riung Karsa

UNIVERSITAS Padjadjaran meluncurkan program baru sebagai media sosialisasi dan promosi berbagai produk hasil riset unggulan dan inovasi yang saat ini banyak dihasilkan oleh para peneliti Unpad dalam berbagai disiplin ilmu.

Program yang merupakan bagian dari *media relations* ini akan dikemas dalam bentuk obrolan santai sambil minum kopi di sore hari dan diberi nama Riung Karsa (Riset Unggulan Unpad dan Kerja Sama untuk Masyarakat Sejahtera). Program ini akan menjadi diseminasi Informasi dan promosi mengenai hasil-hasil riset dan inovasi *civitas academica* Unpad yang memiliki dampak dan kontribusi bagi masyarakat.

Menurut Keri Lestari Wakil Rektor Unpad Bidang Kerja Sama, Riset, Inovasi, dan Pengabdian Masyarakst Riung Karsa merupakan wahana Unpad untuk *ngahiji* dengan masyarakat melalui kehendak dan cita-cita Unpad sebagai World Class University dengan niat luhur membangun masyarakat sejahtera berbasis riset unggulan dan kerja sama Unpad. Menguatkan kerja sama, Riung Karsa mendorong kolaborasi yang lebih banyak dengan masyarakat luas. Selain menghadirkan pembicara dari kalangan akademisi, Riung Karsa juga akan mengundang para kolaborator, pelaku bisnis dan pihak-pihak yang terkait dengan penelitian, serta insan media dari berbagai media massa.

Pentahelix

Rektor Unpad Tri Hanggono Achmad mengatakan, program "Riung Karsa" merupakan upaya Unpad dalam mendiseminasikan berbagai hasil penelitian kepada masyarakat melalui pendekatan kerja sama Pentahelix. Ia menilai, penghiliran penelitian tidak akan efektif jika hanya dilakukan secara parsial. Seluruh unsur terkait seperti pemerintah, pelaku usaha, masyarakat, dan media memiliki peran penting dalam menjadikan riset yang dilakukan memiliki manfaat di masyarakat.

Tri mengatakan, sebagai program perdana Riung Karsa akan mengangkat hasil riset yang dilakukan oleh Smart Apiculture Management Services (SAMS). SAMS merupakan *project* riset internasional di bawah program Horizon 2020 ICT-39 Uni Eropa dengan tema kemitraan internasional dalam membangun negara-negara berpendapatan menengah dan menengah ke bawah. Projek ini bertujuan meningkatkan kerja sama internasional (ICT) dan pertanian berkelanjutan antara Uni Eropa dan negara-negara berkembang dalam mengejar komitmen EU untuk mengakhiri kelaparan, mencapai ketahanan pangan dan peningkatan gizi serta mempromosikan pertanian berkelanjutan.

FOTO: HUMAS UNPAD

*BERAWAL dari dialog sambil ngopi, lahirlah diskusi-diskusi yang berujung pada kegiatan riset. Kegiatan tersebut akhirnya diberi nama Riung Karsa (Riset Unggulan Unpad dan Kerja Sama untuk Masyarakat Sejahtera). Penelitian pertama yakni tentang keberadaan lebah.**

Kesehatan lebah dan eksisting perlebahan adalah kunci untuk pertanian berkelanjutan di seluruh dunia. Semakin berkurangnya produksi madu menandakan populasi lebah yang ada di dunia pun semakin berkurang, hal ini akan memengaruhi ekosistem lingkungan terutama daerah hutan yang menjadi sumber kehidupan hewan, tumbuhan bahkan manusia karena peran lebah yang sangat penting dalam penyerbukan secara alami (polinasi).

SAMS *project* memungkinkan para peternak lebah memantau secara aktif kesehatan lebah dan aktivitas lebah dalam sarang melalui pengembangan ICT yang tepat dalam mendukung pengelolaan kesehatan lebah dan produktivitas lebah serta menjadi contoh sistem kolaborasi internasional yang aktif. Melalui penerapan riset dan inovasi, program ini menitikberatkan pada penciptaan keunggulan pengetahuan, keunggulan industri, dan mempersiapkan perubahan sosial di masa yang akan datang.

Selain itu, SAMS *project* diharapkan dapat menciptakan lapangan pekerjaan (khususnya pemuda-/wanita), memicu investasi dan pertukaran ilmu pengetahuan melalui perluasan jaringan. Lebih lanjut, hasil dari SAMS akan memberikan daya tarik-menarik bagi pemangku kepentingan sepanjang seluruh mata rantai produksi madu dan kelestarian lingkungan.

SAMS *sense* proyek melibatkan beberapa pihak dalam konteks Penta Heliks yaitu melibatkan para periset lintas disiplin ilmu di Universitas Padjadjaran dan mitra konsorsiumnya yakni GIZ Germany, Universitas Kassel Jerman, Universitas Latvia, Univeritas Graz Austria, Ideadis Ethopia, JOQQ Etiopia, serta Primary Indonesia dan Commonroom Network. Di Indonesia sendiri, untuk memperluas dampaknya telah terkoneksi lebih dari 18 pihak Komunitas Perlebahan, Dinas Kehutanan, Pebinis Lebah Madu dan ICT, serta pelibatan media.

Grant riset ini merupakan lanjutan dari rangkaian riset inovasi sosial yang mengintroduksi teknologi tepat guna untuk diterapkan di masyarakat. Sebelumnya, SAMS *project* ini, selama lima tahun berturut-turut mendapatkan dukungan pendanaan dari Unpad dalam bentuk Hibah Riset Internal Unpad Skema PUPT & RHPU, BP3IPTEK Pemprov Jabar hingga akhirnya mendapat dukungan internasional melalui Horizon 2020 Uni Eropa.

Kepala Kantor Komunikasi Publik Unpad Ade Kadarisman mengatakan, program "Riung Karsa" merupakan program komunikasi publik berbasis pengarustamaan riset dan inovasi. Pembumian hasil riset yang bermanfaat bagi masyarakat saat ini telah banyak ditunggu oleh berbagai pihak baik pemerintah, masyarakat maupun industri. Untuk itu, proses diseminasi informasi dilakukan dengan kolaborasi aktif dengan media. Direncanakan program ini akan diselenggarakan tiap hari Jumat sore sambil ngopi santai sebagai jembatan komunikasi antara universitas dan berbagai pemangku kepentingan untuk berinteraksi dan berkolaborasi. (**Erwin Kustiman/"PR"**)***

Abstract of Afternoon Coffee at Riung Karsa

University Padjadjaran (UNPAD) launched Riung Karsa, an activity carried out with the objective to disseminate research and innovation programs carried out by UNPAD. Taking the theme of chatting casually by inviting several stakeholders from the general public, the media, and local figures.

Rector of University Padjadjaran, Tri Hanggono, explained that Riung Karsa will become a forum for UNPAD to disseminate its research and innovation programs carried to the public so that the public will be more aware of these UNPAD programs.

The first theme discussed during the Riung Karsa event, is the Smart Apiculture Management Services (SAMS) project an international research. This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement N° 780755. It includes following partner: German Development Cooperation (GIZ) and Kassel University from Germany, Latvia University of Life Sciences and Technologies from Latvia, Graz University from Austria, Holeta Bee Research Center and Iceaddis IT Consultancy PLC from Ethiopia, as well as University Padjadjaran and CV Primary Indonesia from Indonesia.

The SAMS Project is a research project which develops and ICT solution for the beekeeping sector, a bee colony monitoring tool using different sensors. Apart from focusing on the development of such colony system, SAMS also focuses on creating new jobs, especially those that actively involve women. UNPAD researchers, involved in the SAMS research program, also apply the Pentahelix concept, in which various stakeholders are involved.

1.1.10 January 2020 – UNPAD Website and other Local News Website – UNPAD Bandung Bee Sanctuary

Unpad   UNIVERSITAS   FAKULTA

Perdana di Kota Bandung, Unpad Kembangkan Budidaya Lebah

Laporan oleh M. Dzulfikri Firdaus

Rektor Universitas Padjadjaran Prof. Dr. Rina Indiastuti, M.SIE., meninjau lokasi budidaya lebah milik Unpad di komplek Pusat Psikologi Bandung, Jalan Ir. H. Djuanda Nomor 438-B, Bandung, Jumat (10/1). (Foto: Arief Maulana)*

[unpad.ac.id, 10/1/2020] Rektor Universitas Padjadjaran Prof. Dr. Rina Indiastuti, M.SIE., meresmikan pusat budidaya dan edukasi lebah yang berlokasi di komplek Pusat Psikologi Unpad, Jalan Ir. H. Djuanda, Bandung, Jumat (10/1).

Bertepatan dengan Hari Lingkungan Hidup Indonesia, diresmikan Bandung Bee Sanctuary (BBS) sebagai pusat budidaya dan edukasi lebah berbasis teknologi pertama di Bandung. Peresmian BBS ditandai dengan penandatanganan stup lebah dan penanaman bibit pohon oleh Rektor Unpad.

BBS merupakan salah satu Program Riset Hilirisasi Produk Unggulan (RHPU) Universitas Padjadjaran yang mulai dirancang pada bulan Juli 2019, Program ini selain bertujuan sebagai sumber potensi pengembangan budidaya lebah, dan menghubungkan bagaimana riset Unpad mampu memberikan dampak langsung dalam kegiatan sosial kepada masyarakat dan para stakeholders untuk membuka peluang kolaborasi dalam perluasan dampak positif.
BBS berdiri diatas lahan seluas 7 hektar dalam komplek Pusat Psikologi Unpad.

Dalam sambutannya Rektor menyampaikan apresiasi tinggi dan dukungannya atas inisiasi BBS. Menurutnya BBS adalah contoh socio-teknopreneurship yang baik.

"Munculnya kreativitas perlu diwujudkan dengan kolaborasi dan tekad kuat, dan saya mengucapkan selamat kepada para dosen dan peneliti kita, yang telah bergerak mencari kolaborator tidak hanya pada bidangnya, tetapi pada bidang lain yang mampu mewujudkan kreativitas tanpa batas, juga bagi mahasiswa yang ingin menunjukkan eksistensi dan peranannya dalam kolaborasi ini," ungkap Prof. Rina.

Rektor berharap agar BBS mampu dieksplor untuk masyarakat luas, dilestarikan, ditingkatkan, dan direkognisi berbagai stakeholder dari Jawa Barat, nasional, bahkan internasional. Ini sejalan dengan komitmen Unpad sebagai institusi pendidikan yang membangun sumber daya manusia berkualitas, juga terus melakukan pengabdian pada masyarakat.

Baca juga: **Sebanyak 104 Tim dari Seluruh Indonesia Ikuti U-Camaintian 2013**

Rektor juga berpesan untuk terus menumbuhkan kreativitas, memunculkan tantangan baru, dengan dukungan kolaborasi serta tekad belajar sepanjang hayat, maka kreativitas tanpa batas akan memiliki saluran yang positif.

Sementara itu, Wakil Dekan Fakultas Teknologi Industri Pertanian Dr. Dwi Purnomo, STP., MT., dalam sambutannya, memperkenalkan teknologi berbasis IoT (Internet of Things) pada BBS untuk budidaya lebah, yang saat ini dalam proses pengembangan hingga siap pakai oleh para peternak lebah.

Diharapkan BBS menjadi tempat pertumbuhan dan pengembangan kapasitas dan kualitas wirausaha masyarakat dengan memerhatikan aspek kelestarian lingkungan. (am)*

Abstract of UNPAD establish 1st Bee Cultivation Center in Bandung

Coinciding with the Indonesia's Environment Day, the Bandung Bee Sanctuary (BBS) was established as a first technology-based bee cultivation and education center in Bandung. The launching of the BBS was marked by a signing ceremony with the rector of UNPAD.

The Bandung Bee Sanctuary (BBS) is one of the downstream products of University Padjadjaran (UNPAD) research in Smart Apiculture Management Services Project (SAMS Project) funded by the European Union. The Bandung Bee Sanctuary is a clear example of UNPAD's efforts in grounding its research and innovation programs to the industrial and community levels.

The area of the BBS about 7 hectares and is located on one of the UNPAD lands in the Dago Bandung area. The land, which was previously neglected and used to be a wasted land, has been turned into a bee farm, planted with various types of flowers. The types of bees placed at BBS were not only Apis cerana, but also Trigona Sp. which is a stingless bee that is becoming a trend for beekeepers in West Java.

BBS is expected not only to function as a bee farm, but also to become an ecosystem for the development of bees in Indonesia, especially West Java. Furthermore, the BBS shall be a center for beekeeping research, community education, tourist sites, as well as an example of urban beekeeping.

1.1.11 January 2020 – several Local News Website – UNPAD Bandung Bee Sanctuary

There have been 10 more press releases about the opening of the Bandung Bee Sanctuary in several local news sections. As they all focus on the same content only the links and a sequence of the articles are provided but not the complete article:

Republika - UNPAD launches Bandung Bee Sanctuary


REPUBLIKA.co.id

HOME NEWS NUSANTARA KHAZANAH ISLAM DIGEST INTERNASIONAL EKONOMI REPUBLIKBOLA LEISURE PIKADA 2020

Fahrzeug-Ortungsgeräte

Unpad Luncurkan Bandung Bee Sanctuary

Jumat 10 Jan 2020 15:19 WIB


ANTARANEWS.com

HOME POLITIK HUKUM EKONOMI METRO SEPAKBOLA OLAHRAGA HUMANIORA LIFESTYLE

FOKUS INFOGRAFIK FOTO VIDEO TEKNO OTOMOTIF WARTA BUMI KARKHAS ANTI HOAX ANTARA INTERAKTIF

Einkaufen bei Kaufland

Tingkatkan produksi madu melalui sentuhan teknologi

Jumat, 10 Januari 2020 17:38 WIB

ANTARA - Universitas Padjadjaran (UNPAD) mengembangkan teknologi budidaya lebah di Kawasan Dago, Bandung, Jawa Barat, jumat pagi. Dengan sentuhan teknologi tersebut, produktivitas lebah madu semakin maksimal karena dapat terkontrol melalui gawai. Madu yang dihasilkan pun bisa dijadikan berbagai produk makanan sehat dan juga menguntungkan.(Dian Hardiana/Chairul Fajri/Sizuka)

Antaranews – Increase honey production through technology intervention

[Ayobandung](#) - Honey Products at Bandung Bee Sanctuary

AYOBANDUNG.COM
SEMUA TENTANG BANDUNG
BANDUNG RAYA UMUM PERSIB OLAHRAGA GAYA HIDUP BISNIS BANDUNG BAHEULA

Produk Olahan Madu di Bandung Bee Sanctuary

Jumat, 10 Januari 2020 15:49 WIB M. Naufal Hafizh

Sejumlah pengunjung berbincang tentang produk olahan dari madu dalam acara launching Bandung Bee Sanctuary (BBS), Jalan Ir H Juanda, Kota Bandung, Jumat (10/1/2020). Kepala tim riset Bandung Bee Sanctuary Dwi Purnomo mengatakan, BBS tersebut mengusung konsep inovasi sosial. Lebah yang memiliki potensi bisa dimanfaatkan sebagai model bisnis baru, produk turunan lebah akan terus memiliki nilai ekonomi yang tinggi. (Ayobandung.com/Irfan Al-Faritsi)

AYOBANDUNG.COM
SEMUA TENTANG BANDUNG
BANDUNG RAYA UMUM PERSIB OLAHRAGA GAYA HIDUP BISNIS BANDUNG BAHEULA

Unpad Resmikan Bandung Bee Sanctuary

Jumat, 10 Januari 2020 17:43 WIB Nur Khansa Ranawati

Universitas Padjadjaran melalui komunitas bisnis The Local Enablers meresmikan kebun budidaya lebah

[Ayobandung](#) - UNPAD Officially Launched Bandung Bee Sanctuary

[Ayobandung](#) – Bandung Bee Sanctuary

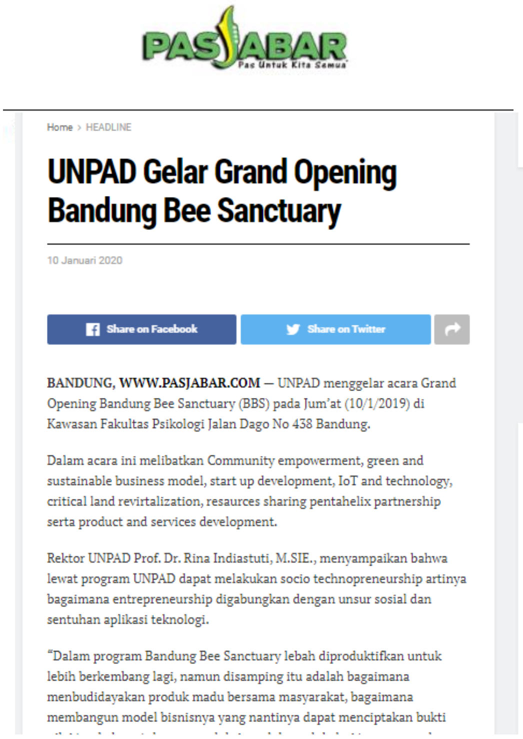
AYOBANDUNG.COM
SEMUA TENTANG BANDUNG
BANDUNG RAYA UMUM PERSIB OLAHRAGA GAYA HIDUP BISNIS BANDUNG BAHEULA

Bandung Bee Sanctuary

Jumat, 10 Januari 2020 17:38 WIB M. Naufal Hafizh

Petugas mengeluarkan sarang dari kotak setup lebah, di Kebun Lebah Unpad, Bandung Bee Sanctuary (BBS), Jalan Ir H Juanda, Kota Bandung, Jumat (10/1/2020). Universitas Padjadjaran bersama The Local Enablers memperkenalkan Bandung Bee Sanctuary yang merupakan pusat pembudidayaan dan edukasi lebah berbasis teknologi di Bandung. (Ayobandung.com/Irfan Al-Faritsi)

Pasjabar - UNPAD Held Grand Opening of Bandung Bee Sanctuary



PASJABAR Pas Untuk Kita Semua

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UNPAD Gelar Grand Opening Bandung Bee Sanctuary

10 Januari 2020

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BANDUNG, WWW.PASJABAR.COM — UNPAD menggelar acara Grand Opening Bandung Bee Sanctuary (BBS) pada Jum'at (10/1/2019) di Kawasan Fakultas Psikologi Jalan Dago No 438 Bandung.

Dalam acara ini melibatkan Community empowerment, green and sustainable business model, start up development, IoT and technology, critical land revitalization, resaurces sharing pentahelix partnership serta product and services development.

Rektor UNPAD Prof. Dr. Rina Indiastuti, M.SIE., menyampaikan bahwa lewat program UNPAD dapat melakukan socio technopreneurship artinya bagaimana entrepreneurship digabungkan dengan unsur sosial dan sentuhan aplikasi teknologi.

"Dalam program Bandung Bee Sanctuary lebah diproduktifkan untuk lebih berkembang lagi, namun disamping itu adalah bagaimana menbudidayakan produk madu bersama masyarakat, bagaimana membangun model bisnisnya yang nantinya dapat menciptakan bukti

IDN TIMES JABAR

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Bisnis Baru Anak Muda, Beternak Lebah Madu yang Menguntungkan

Produksi madu lokal dari Indonesia masih minim

IDN Times/Debbie Sutrisno

IDN Times Jabar - New business for young people -profitable beekeeping business

jabarprov.go.id - Approaching millennial farmers through BBS

Berita Website Resmi Pemerintah Provinsi Jawa Barat

Dekatkan Petani Milenial Melalui BBS

2020-01-10 17:10:00 | BERITA | 2066 VIEWS | 0 KOMENTAR | SUMBER : REP NO

BANDUNG-Universitas Padjadjaran (Unpad) mengembangkan penelitian tentang pelebahan di Indonesia dengan tujuan agar masyarakat lebih memahami bagaimana cara mengembangkan usaha perlebahan secara baik sehingga memiliki ekonomi tinggi.

Menurut Ketua Tim Riset Bandung Bee Sanctuary (BBS), Dwi Purnomo,yang membedakan dengan penelitian serupa yaitu riset ini adalah sinerginya, dimana teknologi hanya sebagai katalis terhadap perkembangan dan konsep ini bisa diikuti oleh anak muda karena memiliki teknologi kekinian.

"Yang membedakan adalah bagaimana ini bisa digunakan oleh petani dan yang paling penting adalah satu dari 5 bagian yang lainnya seperti pemberdayaan manusia, menurunkan dengan produk turunan, nilai tambah dan investasi sosial," ucapnya

Dwi mengatakan, ini merupakan salah satu program Riset Hilirisasi Produk Unggulan (RHPU) yang mulai dirancang pada Juli 2019 dan telah berhasil memetakannya menjadi model bisnis yang utuh tidak sendiri-sendiri dan merupakan kolaborasi kanan kiri

"Jadi kalau teknologinya ini adalah yang pertama di indonesia karena melibatkan banyak sensor yang terkait dengan lingkungan, suhu, panas kelembaban, suara dll," kata Dwi, dalam Launching Kebun Lebah Unpad-BBC, Dago, Jumat (10/01).

Dwi menyatakan, hasil riset ini akan terus dikembangkan menjadi model bisnis baru yang bisa direplikasi di daerah lain dengan sedikit penyesuaian sesuai kebutuhan masing-masing daerah karena dapat memberikan dampak langsung dalam kegiatan sosial kepada masyarakat dan juga kepada berbagai macam pemangku kebijakan.

Berita Website Resmi Pemerintah Provinsi Jawa Barat

Teknologi Berbasis IoT Kembangkan Budidaya Lebah

2020-01-10 17:00:00 | BERITA | 898 VIEWS | 0 KOMENTAR | SUMBER : REP NO

BANDUNG- Universitas Padjadjaran (Unpad) berhasil memanfaatkan lahan seluas 7 hektar di sekitar Dago Atas, Bandung tepatnya di belakang gedung Psikologi Unpad yang sebelumnya penuh dengan semak belukar menjadi tempat budidaya lebah dengan menggunakan teknologi sensor yang dikembangkan Fakultas Teknologi Industri Pertanian (FTIP) Unpad.

Belasan kandang lebah untuk menampung madu telah terpasang dan ekosistem untuk membangun vegetasi kehidupan lebah telah ditanam, mulai dari bunga matahari, kacang tanah, hingga pohon petai cina tumbuh di sebagian lahannya.

Menurut Rektor Unpad, Rina Indiastuti, dengan teknologi baru berbasis IoT (Internet of Things) untuk budidaya lebah, nantinya akan membantu peternak lebah untuk mengontrol keadaan sarang dan juga kualitas lebah yang bisa dipantau pergerakannya.

"Dengan teknologi sensor,lebah yang diintegrasikan dengan aplikasi monitoring berbasis mobile yang bisa dipantau dari jarak jauh. Aplikasi ini akan memuat data dan informasi lebah dan juga kondisi sarang seperti suhu, berat, kelembaban dan lain-lain.

Rina mengatakan, dengan teknologi ini peternak akan dimudahkan, dimana mereka akan dapat mengetahui apakah sarang lebah siap panen atau belum tanpa harus bolak-balik mengecek sarang.

"Kita akan tahu bagaimana produktifitas lebah dalam menghasilkan madu, kapan lebah itu bekerja, kapan itu produktif, dan dengan lebah harmonisasi alamnya bisa terjaga melestarikan lingkungan, kolaborasinya berbagai ahli, anak muda, mitra bisnis, pemda, institusi internasional lain," tuturnya.

jabarprov.go.id - IoT-based technology supports beekeeping

kantor pemuda .com

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Pendidikan

Unpad Luncurkan Bandung Bee Sanctuary

Bandung Bee Sanctuary adalah pusat pembudidayaan dan edukasi lebah berbasis teknologi REPUBLIKA.CO.ID, BANDUNG -- Universitas Padjadjaran bersama The Local Enablers memperkenalkan Bandung Bee Sanctuary di Jalan Ir. H. Juanda, Kota Bandung, Jumat (10/1). BBS merupakan pusat pembudidayaan dan edukasi lebah berbasis teknologi di Bandung.Kepala tim riset Bandung Bee Sanctuary, Dwi Purnomo mengatalan BBS mengusung konsep inovasi sosial. Lebah yang memiliki potensi bisa dimanfaatkan sebagai model bisnis baru."Kita akan melakukan bisnis model pemberdayaan, penguatan ekonomi sosial, dan eknologi yang menyamakan pertanian dengan industri 4.0," kata Dwi.Lahan seluas 7 hektare pun akan disulap menjadi peternakan lebah. Untuk meningkatkan sumber daya manusia yang ada, dilakukan pendampingan dengan melibatkan anak muda sebagai pelaku budidaya lebah."Kita melibatkan 100 orang anak muda yang memiliki ketertarikan dengan industri lebah dan mengkolaborasikan dengan berbagai bisnis model yang ada," katanya.Selain menggaet anak muda dari Unpad, Dwi menyebut BBS turut menggaet masyarakat kurang mampu. Seperti peternak lebah yang dahulunya bekerja sebagai

Kantor Pemuda – UNPAD launches Bandung Bee Sanctuary

1.1.12 June 16, 2020 – UNPAD Website – Incubator Beekeeping Businesses during Covid-19 Pandemic

unpad

UNIVERSITAS FAKU

Menjaga Bisnis Perlebahan Tetap "Menyengat" di tengah Pandemi Covid-19

Rilis

(Foto ilustrasi) Aktivitas penangkaran lebah di Bandung Bee Sanctuary (BBS) Pusat Budaya dan Edukasi Lebah Unpad di komplek Pusat Psikologi Unpad, Jalan Ir. H. Djuanda, Bandung, Jumat (10/1). (Foto: Arif Maulana)*

[unpad.ac.id, 16/6/2020] Pandemi Covid-19 menjadi tantangan bagi sektor bisnis. Pelemahan ekonomi yang terjadi di masa pandemi harus dilawan oleh pengusaha, agar bisnis yang dijalankan tetap terjaga kelangsungannya.

Tim Konsorsium *Smart Apiculture Management Services* (SAMS) Universitas Padjadjaran memberikan sejumlah rekomendasi untuk memperbaiki dan meningkatkan bisnis, terutama menghadapi Covid-19. Pengenalan model bisnis ini dipaparkan dalam Webinar "Menjaga Momentum Bisnis Lebah Madu dan Produk Perlebahan Pasca Covid-19 dengan Model Bisnis Inovatif", Sabtu (13/6).

(baca juga: Unpad Terlibat dalam Konsorsium Riset Horizon 2020 ICT-39 Uni Eropa)

Narasumber Webinar yang juga ketua tim SAMS Unpad Dr. Dwi Purnomo, M.T., menjelaskan, pandemi Covid-19 menciptakan dua kondisi dalam bisnis, yaitu naik atau terpuruk. Jika berada pada kondisi naik, keberlanjutannya harus dijaga.

Dalam rilis yang diterima Kantor Komunikasi Publik Unpad , Dr. Dwi memaparkan, hal yang dapat dilakukan untuk menjaga momentum di antaranya menjaring data konsumen mulai dari persona, sebaran, preferensi serta perubahan sifat generasi agar tetap relevan di masa mendatang.

Selain itu, menginvestasikan keuntungan bukan hanya untuk mempelajari teknis produksi juga mempelajari model bisnis. Dr. Dwi juga mendorong untuk menyiapkan *webstore* guna mempermudah pengumpulan data.

(baca juga: Konsorisum Riset SAMS Horizon 2020 Uni Eropa Populerkan Kembali Budidaya Lebah)

Apabila berada pada kondisi terpuruk, Wakil Dekan Fakultas Teknologi Industri Pertanian Unpad ini juga menyarankan untuk jangan lekas memutuskan ikatan kerja pegawai atau menjual aset. Keputusan jangka pendek ini bisa menjadi bumerang di masa datang.

Baca juga: **Peneliti Unpad Ciptakan Alat Ukur Kemampuan Dokter Gigi dalam Melakukan Dental Hipnosis**

Sudut pandang saat bisnis terpuruk harus diputar 180 derajat. Pegawai jangan dipandang sebagai beban, tetapi justru sebagai aset yang perlu dijaga. Untuk itu, targetkan pegawai untuk belajar hal baru.

"Kondisi paling kritis saat ini sebenarnya adalah kondisi yang paling memungkinkan muncul ide-ide gila sambil *meeting online* cari titik *pivot*-nya bisa jadi *milestone* baik di masa depan," tambahnya.

Bisnis Potensial

Sektor bisnis perlebahan dan produk turunannya menjadi bisnis potensial di tengah badai pandemi. Berdasarkan hasil analisis sebuah studi lembaga di Mesir terkait posisi ekonomi berbagai sektor bisnis di era pandemi, bisnis perlebahan dan produk turunannya sebagai sektor bisnis *food processing & retail* menduduki posisi kedua sebagai *potential winner*.

(baca juga: Perdana di Kota Bandung, Unpad Kembangkan Budidaya Lebah)

Sebagai salah satu suplemen kesehatan, madu kini menjadi primadona bagi masyarakat untuk menjaga ketahanan tubuh di masa pandemi.

Analisis ini juga dibenarkan oleh penggiat perlebahan yang menjadi peserta pada Webinar ini. Menurut para peserta, di balik pandemi Covid, bisnis perlebahan yang dijalankan justru mendapat keberkahan. Omzet penjualan pun melejit.

Karena itu, materi Webinar ini diharapkan dapat diaplikasikan untuk mendukung ketahanan bisnis perlebahan di Indonesia. Apalagi, jika dilihat dari lokasi peserta Webinar, ada optimisme sektor perlebahan di Indonesia tetap bangkit.

Webinar ini dihadiri oleh 64 penggiat dunia perlebahan dan *apiculture enthusiast* dari berbagai daerah Indonesia baik wilayah Pulau Jawa maupun Luar Jawa. Selain itu, webinar ini mendapatkan respons positif dari peserta.

"Dengan melihat persebaran ini, Indonesia memiliki potensi yang baik dalam meningkatkan produksi madu dan produk perlebahan lainnya yang sampai hari ini kebutuhan pasarnya belum dapat terpenuhi oleh produksi lokal," kata Dr. Dwi.

Baca juga: **PTN Badan Hukum Harus Mampu Tingkatkan Mutu Akademiknya**

(baca juga: Unpad Dorong Masyarakat Sadar Potensi Budidaya Lebah)

Inkubasi Bisnis Lebah

Dalam Webinar yang didukung oleh The Local Enablers, Asosiasi Perlebahan Indonesia (API), dan *Indonesia Creative Cities Network* (ICCN), tim SAMS Unpad akan meluncurkan program inkubasi *online* untuk peserta penggiat perlebahan yang telah mengikuti webinar selama 7 minggu.

Pembinaan ini dikhususkan untuk bidang perlebahan dalam rangka mendukung penggiat bisnis perlebahan menjaga momentum baik yang didapat lewat pandemik Covid-19. Pembinaan ini tidak terbatas pada kalangan yang sudah memiliki bisnis perlebahan saja, tetapi untuk kalangan yang belum memiliki bisnis perlebahan dan tertarik untuk memulai bisnis di bidang ini.

Dengan begitu, kesempatan untuk memenuhi kebutuhan pasar akan produk perlebahan semakin terbuka lebar.(art)*

Short abstract of Beekeeping Businesses during Covid-19 Pandemic

The conditions for the spread of the Covid-19 pandemic have had a huge impact on the business world, many business lines have been forced to close due to the impact of the Covid-19 pandemic. These various business lines start from food, beverage, tourism, etc.

However, it turns out that Covid-19 also provides a breath of fresh air for bee product businesses, especially honey sales in Indonesia. There has been a significant increase in demand and sales of honey products in the market.

The SAMS University Padjadjaran team carried out a web-seminar activity with the theme "Maintaining the Post-Covid-19 Beekeeping and Bee Product Business Momentum with an Innovative Business Model". This web-seminar was intended to provide insight to the beekeeping sector and related business as well as business opportunities by providing business model canvas knowledge.

Such web-seminar series, especially on Business Model Canvas, shall enable the sector to take advantage of the pandemic and grow out of it.

1.1.13 July 11, 2020 – UNPAD Website – SAMS UNPAD research team launches business incubation program for beekeeping businesses


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UNIVERSITAS FAKUL

Tim Riset SAMS Unpad Luncurkan Program Inkubasi Bisnis untuk Usaha Perlebahan

Rilis

www.unpad.ac.id

Kotak stup lebah di Pusat Budidaya dan Edukasi Lebah milik Unpad yang berlokasi di komplek Pusat Psikologi Unpad, Jalan Ir. H. Djuanda, Bandung. (Foto: Arif Maulana)* [unpad.ac.id, 11/7/2020] Universitas Padjadjaran melalui tim riset internasional *Smart Apiculture Management Services* (SAMS) meluncurkan program inkubasi model bisnis inovatif untuk pelaku usaha perlebahan. Sebanyak 180 peserta mengikuti program inkubasi ini.

Peluncuran program inkubasi dilakukan melalui pertemuan daring yang digelar, Jumat (3/7). Peserta program tidak hanya berasal dari Jawa Barat, tetapi juga berasal dari berbagai daerah di Indonesia. Sejumlah pelaku usaha perlebahan, mulai dari peternak lebah, pebisnis, penyuluh, pemerintah, hingga masyarakat yang menaruh minat di bidang perlebahan, menjadi partisipan program ini.

(baca juga: Menjaga Bisnis Perlebahan Tetap “Menyengat” di tengah Pandemi Covid-19)

“Program ini dirancang untuk membantu penggiat bisnis perlebahan untuk memperbaik model bisnis mereka dengan model bisnis inovatif dan membantu apiculture enthusiast dalam melakukan ideasi bisnis inovatif perlebahan & produknya,” ujar ketua tim riset SAMS Unpad Dr. Dwi Purnomo, M.T., yang membawahi program inkubasi ini.

Dalam keterangan tertulis kepada Kantor Komunikasi Publik Unpad, Dwi juga menjelaskan, program inkubasi ini diharapkan bisa berpengaruh terhadap penguatan modle bisnis UMKM di bidang usaha perlebahan, perubahan pola pikir dan peningkatan kapasitas pelaku usaha, penguatan ekosistem bisnis, hingga penguatan ekonomi masyarakat.

Program pertama yang akan dijalankan dalam inkubasi ini adalah pembuatan model bisnis kanvas. Model bisnis kanvas menghasilkan produk yang dibutuhkan konsumen secara layak dan berkelanjutan.

Realisasinya, peserta inkubasi akan dibagi menjadi beberapa tim. Setiap tim akan dipanc oleh fasilitator. “Pengelompokkan tim ini akan membantu peserta mengikuti inkubasi dengan lebih terarah dan terbimbing,” tutur Dwi.

Baca juga: **Finder U-CoE Unpad, Perintis Kajian Nanoteknologi di Perguruan Tinggi**

(baca juga: Perdana di Kota Bandung, Unpad Kembangkan Budidaya Lebah)

Program inkubasi akan dibagi menjadi 7 sesi pertemuan. Diharapkan peserta dapat mencapai level usaha yang lebih tinggi.

“*Outcomes* dari program ini adalah peserta diharapkan mampu menjalankan bisnis usah perlebahan dengan diversifikasi produk, menjalankan sistem Objective Key Results (OKRs), peningkatan manajerial dan kapabilitas tim,” katanya.

(baca juga: Unpad Dorong Masyarakat Sadar Potensi Budidaya Lebah)

Selain itu, peserta program dapat memahami segmentasi pasar lebih baik, mampu melihat kebutuhan konsumen, mampu menjaga hubungan dengan pelanggan dan mitra,serta mampu membentuk kolaborasi.

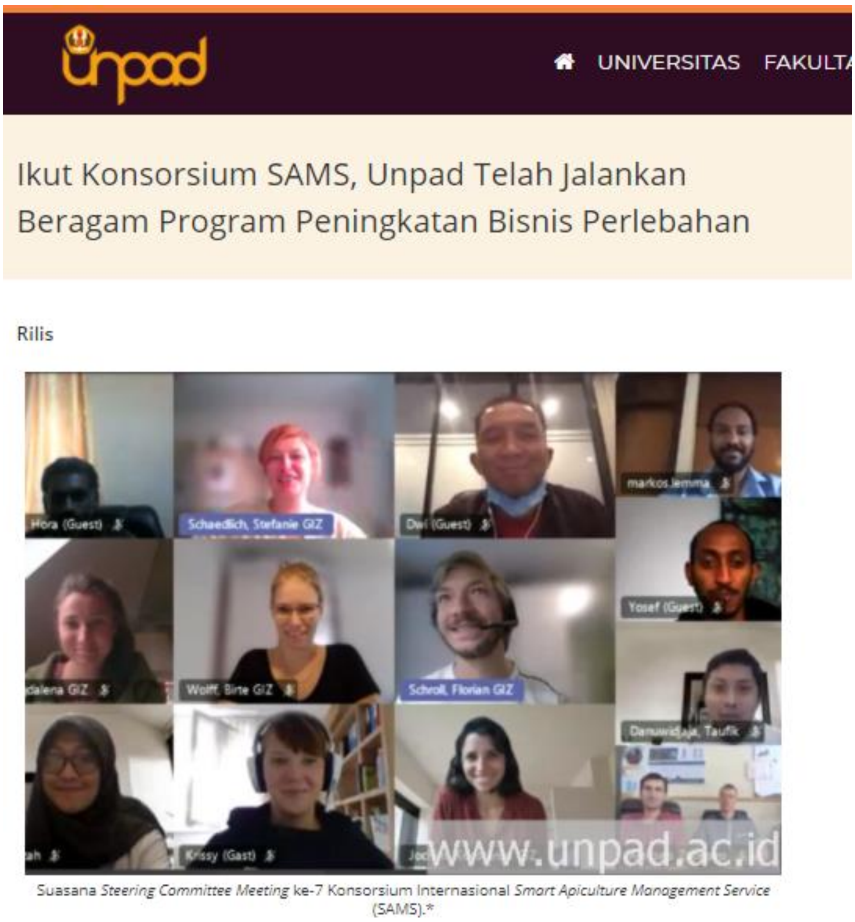
Kepala Bagian Perencanaan Dinas Kehutanan Provinsi Jawa Barat Aris Dwi Subiantoro yahg hadir dalam acara peluncuran mengatakan, program inkubasi ini selaras dengan upaya pemprov dalam pengembangan perlebahan di Jabar. Hal ini bertujuan untuk menjadikan Jabar sebagai lumbung madu nasional.(art)*

Short abstract of SAMS UNPAD research team launches business incubation program for beekeeping businesses

University Padjadjaran launched an innovative business model incubation program for beekeeping businesses as part of the Smart Apiculture Management Services (SAMS) international research team. A total of 180 participants applied to this incubation program which were not only from West Java, but also come from various regions in Indonesia. The incubation program was launched through an online event that was held on Friday (3/7). Several beekeeping business actors, ranging from beekeepers, businessmen, extension workers, government, to people who are interested in beekeeping, participated in this program.

This program is designed to help beekeeping businesspeople to improve their business models with innovative business models and assist apiculture enthusiasts in carrying out innovative beekeeping and develop business as well as product ideas. The incubation program will be divided into 7 meetings. Participants are expected to achieve higher levels of business.

1.1.14 October 11, 2020 – UNPAD Website – The SAMS Consortium, UNPAD supported various beekeeping business improvement programs



[unpad.ac.id, 1/10/2020] Proyek Konsorsium Internasional *Smart Apiculture Management Service* (SAMS) saat ini telah menginjak akhir periode dari tiga tahun pelaksanaan sejak Januari 2018 lalu. Tim SAMS Unpad pun telah melaksanakan berbagai kegiatan yang berfokus pada bisnis perlebahan Indonesia.

Hal tersebut disampaikan tim SAMS pada *Steering Committee Meeting* ke-7 yang dilaksanakan secara daring pada 23 – 25 September 2020 lalu.

Pada periode Maret-September 2020, program yang sudah dilakukan tim SAMS Unpad di antaranya melakukan penulisan laporan market survei yang dilaksanakan bulan Januari – Februari 2020 (laporan dapat diakses melalui *website* SAMS), mencari mitra bisnis perlebahan yang akan diberikan dukungan oleh SAMS, serta melaksanakan webinar dan inkubasi model bisnis inovatif perlebahan.

(baca juga: Tim Riset SAMS Unpad Luncurkan Program Inkubasi Bisnis untuk Usaha Perlebahan)

"Harapannya dari kegiatan-kegiatan ini, Indonesia bisa semakin maju dalam bisnis perlebahan yang bukan hanya mencakup peternak atau penjual madu, tetapi juga dengan melibatkan *stakeholder* lain yang tergabung dalam *value chain*/rantai pasok bisnis perlebahan seperti pemerintahan, organisasi, dan akademisi," ujar Ketua tim riset SAMS Unpad Dr. Dwi Purnomo, M.T., dalam rilis yang diterima Kantor Komunikasi Publik (KKP) Unpad.

Steering Committee Meeting sendiri rutin dilaksanakan SAMS setiap 6 bulan sekali. Pertemuan ini biasanya dilakukan di salah satu negara anggota konsorsium yang berlokasi di Eropa.

(baca juga: Tindak Lanjut Program SAMS, Unpad Gelar Lokakarya "User Centered Design")

Namun, pada *Steering Committee Meeting* ke-7 kali ini terdapat perbedaan dalam pelaksanaannya. Kondisi dan perkembangan Covid-19 yang berbeda di tiap negara membuat pertemuan ini digelar secara daring.

Baca juga: **Darma Wanita Unpad Beri Santunan kepada Sejumlah Lansia di Desa Cileles dan Cilayung**

"*Steering Committee Meeting* kali ini adalah yang pertama dilakukan secara daring setelah 6 pertemuan sebelumnya selalu dilaksanakan dengan tatap muka," ungkap Dr. Dwi.

Dalam pertemuan kali ini, seluruh anggota konsorsium SAMS menyampaikan kegiatan setiap *work package* dari setiap negara yang telah dilaksanakan sejak Maret – September 2020. Selain itu, seluruh anggota konsorsium juga berdiskusi mengenai langkah-langkah kerja yang dapat dilakukan demi mencapai tujuan dan dampak yang dharapkan, sesuai dengan yang telah dirumuskan di awal proyek. (art)*

Short abstract of The SAMS Consortium, UNPAD supports various beekeeping business improvement programs

The project Smart Apiculture Management Service (SAMS), which has been implemented since 2018, has entered its last year. Various activities have been carried out by members of the SAMS consortium, including University Padjadjaran (UNPAD). One of the regular activities is the Steering Committee Meeting (SCM).

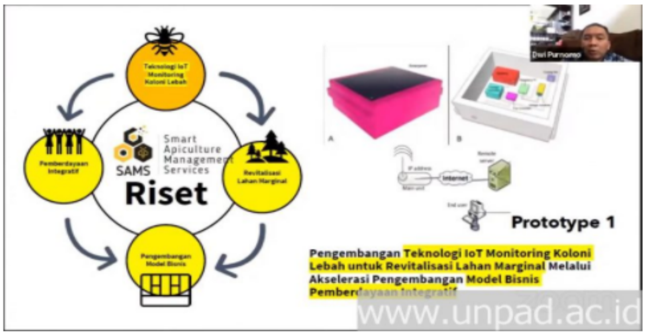
Unlike the previous six SCM, which were always conducted in Europe in person, this 7th SCM had to be carried out online due to the Covid-19 pandemic. On the occasion of the 7th SCM, the UNPAD team explained the activities that have been carried out since March-September 2020. Likewise, with other consortium members who explained the activities they have carried out.

1.1.15 December 09, 2020 – UNPAD Website – UNPAD from the SAMS Consortium Presents Research Results in Beekeeping IoT

UNIVERSITAS FAKULTAS

Konsorsium SAMS Unpad Paparkan Hasil Penelitian di Bidang IoT Perlebahan

Rilis



peneliti utama SAMS UnpadDr. Dwi Purnomo, M.T., saat menjadi narasumber dalam webinar bertajuk "Beekeeping Then & Now" bagian dari "Festival Lebah Madu" atau "Bee Fest", 22 November lalu.*

[unpad.ac.id, 9/12/2020] Konsorsium riset internasional "Smart Apiculture Management Services (SAMS) yang diikuti Universitas Padjadjaran sejak awal 2018 sudah mencapai akhir proyek di pengujung tahun 2020.

Guna mendiseminasikan hasil riset SAMS, khususnya yang dilakukan anggota konsorsium asal Indonesia terkait penerapan teknologi IoT di bidang apikultur, Unpad bersama CVPI, The Local Enabler, dan Labtek Indie menggelar "Festival Lebah Madu" atau "Bee Fest" secara virtual pada 21-22 November lalu.

Acara ini diikuti oleh 118 peserta dari berbagai daerah di Indonesia. Peserta berasal dari kalangan mahasiswa yang tertarik dengan teknologi perlebahan, wirausahawan, peternak lebah, dotsen, hingga pemerintah.

Acara "Bee Fest" terdiri dari tiga rangkaian webinar. Webinar pertama bertema "Creating Social Impact through Internet of Things Live Discussion" digelar pada 21 November dengan narasumber Dr. Andry Alamsyah M.Sc., dari Asosiasi Ilmuwan Data Indonesia dan Anshory Muslim dari eFishery serta dimoderatori Amanda Mita dari Labtek Indie.

Baca juga: Unpad Terbitkan Panduan Penyelenggaraan Kegiatan Pendidikan, Penelitian, dan Kemahasiswaan untuk Semester Genap TA 2020/2021

Pada webinar ini, peserta diajak berdiskusi secara langsung mengenai teknologi IoT secara umum dan pemanfaatannya untuk kemajuan sosial. Rangkaian pertama ini diikuti oleh 71 peserta.

Pada hari kedua, "Bee Fest" dilanjutkan dengan webinar bertajuk "Beekeeping Then & Now". Narasumber pertama, Dr. Ramadhani Eka Putra, PhD, selaku Dosen Institut Teknologi Bandung memaparkan mengenai budidaya lebah madu dan potensinya di Indonesia.

Pembahasan berlanjut mengenai konsep *urban beekeeping* yang diusung oleh Bandung Bee Sanctuary, sebuah bisnis penangkaran lebah berbasis wisata edukasi yang digagas Unpad melalui proyek SAMS dengan narasumber Dr. Dwi Purnomo, M.T., selaku peneliti utama SAMS Unpad dan Yoga Restu Nugraha, S.H.Int. selaku CEO dari Bandung Bee Sanctuary.

Sebanyak 96 peserta webinar juga diajak untuk mengikuti pemaparan tentang pemantauan otomatis aktivitas lebah apis cerana menggunakan pemrosesan citra yang dibawakan oleh Dr. Tony Sumaryada dari Institut Pertanian Bogor.

Webinar hari kedua ditutup dengan "What You Can Do with IoT: Its Positioning in Beekeeping Live Discussion". Sesi ini secara khusus membahas peran IoT dalam perlebahan Indonesia.

Peserta dengan aktif turut berdiskusi dengan para narasumber yang berkecimpung dalam bidang IoT perlebahan, di antaranya adalah Budi Rahardjo dari STEI ITB, Rois Solihin dari Calakan dan Fakhri Rido dari Labtek Indie yang juga Head Engineer SAMS Indonesia.

Baca juga: **Konsep Familiaritas Bahasa untuk Terapi Pasien Afasia Antarkan Riki Nasrullah Jadi Doktor Neurolinguistik**

Tidak berhenti sampai di sana, para peserta Festival Lebah Madu ini diajak untuk melahirkan ide tentang kondisi perlebahan Indonesia saat ini dan kedepannya dengan mengisi kuesioner melalui link https://bit.ly/idelebah2020.

Tim SAMS Unpad berencana memublikasikan kumpulan ide tersebut. Ideasional diharapkan dapat menjadi acuan dan bahan pertimbangan bagi seluruh pemangku kepentingan dunia perlebahan dalam memajukan perlebahan Indonesia.

Rangkaian acara ini diadakan dalam rangka membumikan isu IoT yang masih belum dikenal dalam dunia perlebahan Indonesia dan acara ini pun dimaksudkan untuk menjadi jembatan acara menuju "Final Conference SAMS: ICT in Apiculture". Konferensi SAMS yang diadakan secara internasional ini adalah diseminasi akhir perjalan riset seluruh anggota konsorsium SAMS.(arm)*

Short abstract of UNPAD from the SAMS Consortium Presents Research Results in Beekeeping IoT

The international consortium of the Smart Apiculture Management Services (SAMS) project, of which the University Padjadjaran is a member, reaches its project end in December 2020. In order to disseminate the results of the SAMS project, especially those carried out by consortium members from Indonesia regarding the application of IoT technology in the field of apiculture, UNPAD together with CVPI, The Local Enablers, and Labtek Indie held a virtual "Honey Bee Festival" or "Bee Fest" on November 21-22, 2020.

The 'Bee Fest' event consisted of three main topics, namely "Creating Social Impact through Internet of Things Live Discussion", "Beekeeping Then & Now Web-Seminar", and "What You Can Do with IoT: Its Positioning in Beekeeping Live Discussion".

This event was held in order to bring the IoT topic, which is still uncommon in the Indonesian apiculture sector, more grounded. Moreover, this event was also intended as a bridging event for the "Final Conference of SAMS: ICT in Apiculture" event.

1.1.16 December 11, 2020 – UNPAD Website – SAMS Final Conference - SAMS International Research Consortium presents various beekeeping findings

UNIVERSITAS FAKULT

Konsorsium Riset Internasional SAMS Hasilkan Beragam Temuan di Bidang Perlebahan

Rilis

Konferensi internasional "Information, Communication, and Technology in Apiculture" yang digelar sebagai penutupdari rangkaian perjalanan Konsorsium riset internasional "Smart Apiculture Management Services (SAMS), 25 – 26 November lalu.*

[unpad.ac.id, 11/12/2020] Sebagai penutup dari rangkaian perjalanan Konsorsium riset internasional "Smart Apiculture Management Services (SAMS) , Universitas Padjadjaran bersama anggota SAMS menggelar konferensi internasional yang digelar secara virtual 25-26 November lalu.

Konferensi bertajuk "Information, Communication, and Technology in Apiculture" ini diikuti oleh peserta dari 23 negara. Acara tersebut tidak hanya memaparkan berbagai temuan selama 3 tahun proyek SAMS dilakukan di Indonesia, Ethiopia, dan beberapa negara di Erupa, tetapi juga menjadi ajang diskusi terkait teknologi di bidang perlebahan.

Hari pertama konferensi dibuka dengan pembahasan mengenai proyek SAMS oleh Project Manager Stefanie Schaedlich. Stefanie menjelaskan, proyek SAMS dinanai oleh Uni Eropa dan memiliki 8 anggota institusi dari 5 negara di 3 benua.

Baca juga: **Lises Unpad Tampilkan 10 Tari Tradisional Jabar di Pementasan Sawindu**

"Tujuan SAMS untuk mengembangkan monitoring sistem koloni lebah sehingga membantu peternak lebah dalam mengurus, mengawasi kesehatan dan tingkat produktivitas koloni lebahnya," ujar Stefanie.

Acara kemudian dilanjutkan dengan deskripsi monitoring sistem SAMS Yang dikembangkan oleh tim dari Universitas Kassel serta bagaimana implementasinya di Jerman, Ethiopia, dan Indonesia.

Sesi kedua konferensi hari pertama diisi dengan pemaparan mengenai pengawasan kesehatan lebah oleh Zoologist Dr. Linde Morawetz serta ahli perlebahan Markus Barmann. Hari pertama konferensi kemudian ditutp dengan pembahasaan berbagai keaneakaragam temuan yang didapat tim konsorsium dari 3 benua.

Temuan-temuan tersebut didapatkan pada metode *User Center Design* yang diterapkan dalam pengembangan monitoring sistem SAMS. Peneliti dari Unpad Anas Bunyamin, M.Si., berkesempatan memaparkan temuan selama mengerjakan proyek.

Temuan tersebut didapatkan dari sudut pandang peternak lebah maupun calon peternak lebah yang diberikan materi peningkatan kapasitas pada beberapa kegiatan yang telah dilaksanakan.

Hari kedua konferensi diisi dengan pembahasan materi mengenai "bee data" dan "bee policies" di Indonesia, Ethiopia, dan Eropa, konsep SAMS Business, pengenalan mitra SAMS dan penandatanganan secara virtual *declaration of intent partnership SAMS*.

Baca juga: **Ekstrak Kulit Buah Manggis Berpotensi Sebagai Anti-Covid-19? Ini Studinya**

Pembahasan "*Bee Data*" disampaikan oleh anggota konsorsium dari Latvia University of Life Sciences and Technologies serta beberapa narasumber ahli lainnya dari BeeKing dan BeeXML.

Sesi ini membahas mengenai cara penyimpanan dan pemrosesan data alat monitoring lebah SAMS, kebutuhan data peternak lebah dan juga standardisasi *bee data*.

Sesi pembahasan "bee policies" disampaikan oleh Nur Al Faizah & Taufik Ginanjar Danuwidjaja sebagai perwakilan dari tim SAMS Indonesia, Negash Bekana dari Ethiopian Apiculture Board, dan Thomas M. Klotz seorang *science politician* yang berkecimpung dalam dunia perlebahan.

Materi yang disampaikan sesi ini memperlihatkan bagaimana kematangan dan kesiapan suatu negara dalam perlebahan sangat berpengaruh pada praktek dan kebijakan yang berlaku dalam suatu negara.

Potensi yang besar dalam perlebahan perlu didukung dengan kebijakan dan kesadaran publik yang memadai untuk dapat berkembang dengan baik.

Adapun program "*International ICT Api Partnership*". Kerja sama ini dibentuk dalam rangka menjaga keberlanjutan dari manfaat proyek SAMS.

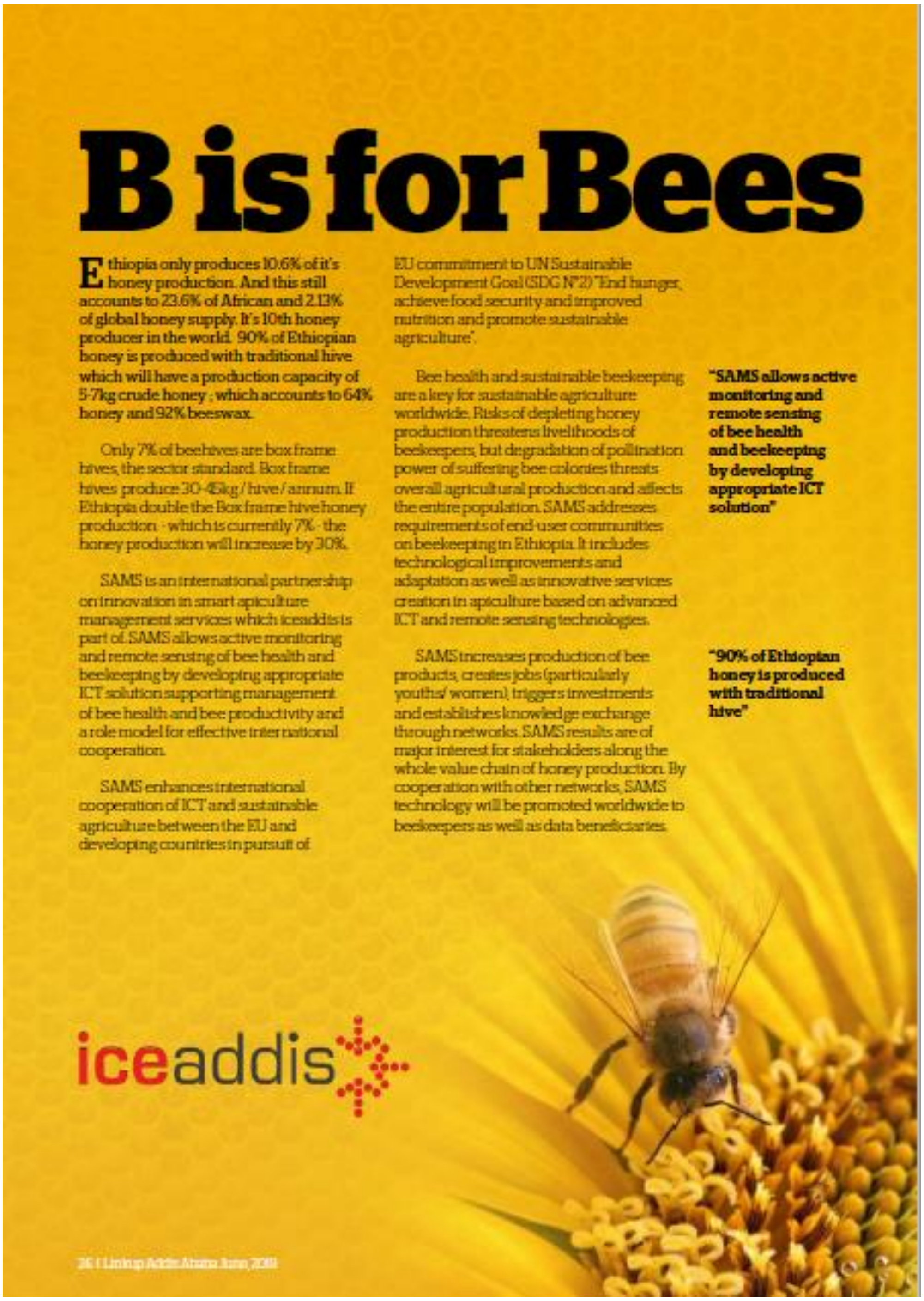
Kerja sama ini mencakup 3 bentuk kegiatan, yaitu *International Partnership on SAMS Business Development; International Partnership on Bee Colony Data and Knowledge Exchange*, serta *International Partnership on Apiculture Technologies and Services*.(art)*

Short abstract of SAMS Final Conference - SAMS International Research Consortium presents various beekeeping findings

As a closing of the research journey of the international research consortium "Smart Apiculture Management Services (SAMS), University Padjadjaran together with the SAMS project team held a virtual international conference on November 25-26, 2020. This article exposed the series of final conference events on the first and second days, such as overall information on the SAMS project presented by Stefanie Schaedlich, SAMS project coordinator; a description of the SAMS monitoring system developed by a team from the University of Kassel and its implementation and adaption in Germany, Ethiopia and Indonesia; findings of UCD process and capacity building activities; information regarding "Bee data" and "bee policies" in Indonesia, Ethiopia, and Europe; the concept of SAMS Business; the introduction of SAMS partnerships and a virtual signing ceremonial of the SAMS partnership declaration of intent.

1.2 Ethiopia

1.2.1 June 2019 – LinkUp Magazine – B is for Bees



B is for Bees

Ethiopia only produces 10.6% of it's honey production. And this still accounts to 23.6% of African and 2.13% of global honey supply. It's 10th honey producer in the world. 90% of Ethiopian honey is produced with traditional hive which will have a production capacity of 5-7kg crude honey ; which accounts to 64% honey and 92% beeswax.

Only 7% of beehives are box frame hives, the sector standard. Box frame hives produce 30-45kg / hive / annum. If Ethiopia double the Box frame hive honey production - which is currently 7% - the honey production will increase by 30%.

SAMS is an international partnership on innovation in smart apiculture management services which iceaddis is part of. SAMS allows active monitoring and remote sensing of bee health and beekeeping by developing appropriate ICT solution supporting management of bee health and bee productivity and a role model for effective inter national cooperation.

SAMS enhances international cooperation of ICT and sustainable agriculture between the EU and developing countries in pursuit of EU commitment to UN Sustainable Development Goal (SDG N°2) "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".

Bee health and sustainable beekeeping are a key for sustainable agriculture worldwide. Risks of depleting honey production threatens livelihoods of beekeepers, but degradation of pollination power of suffering bee colonies threats overall agricultural production and affects the entire population. SAMS addresses requirements of end-user communities on beekeeping in Ethiopia. It includes technological improvements and adaptation as well as innovative services creation in apiculture based on advanced ICT and remote sensing technologies.

SAMS increases production of bee products, creates jobs (particularly youths/ women), triggers investments and establishes knowledge exchange through networks. SAMS results are of major interest for stakeholders along the whole value chain of honey production. By cooperation with other networks, SAMS technology will be promoted worldwide to beekeepers as well as data beneficiaries.

"SAMS allows active monitoring and remote sensing of bee health and beekeeping by developing appropriate ICT solution"

"90% of Ethiopian honey is produced with traditional hive"

iceaddis

1.3 Europe

1.3.1 June 2019 – Climate, Environment, Forest, Biodiversity Newsletter - Monitoring of bees - first systems installed in Indonesia

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Ausgabe Nr. 10 | Juni 2019

Klima, Umweltpolitik, Wald, Biodiversität Newsletter

Aktuelles zu Klima, Umweltpolitik, Wald und Biodiversität
Ein gemeinsamer Service der Bereiche FMB und GloBe

Monitoring von Bienen – erste Systeme in Indonesien und Äthiopien installiert

SAMS Smart Apiculture Management Services

SAMS Logo. © GIZ/UNPAD

SAMS, ein durch das Forschungs- und Innovationsprogramm Horizon 2020 der Europäischen Union (GA No° 780755) finanziertes Projekt, zielt darauf ab, Forschungsdaten durch das digitale SAMS Monitoringsystem zu generieren. Ausgewertete Daten sollen so u.a. Rückschlüsse auf Bienengesundheit & -produktivität ermöglichen und die Imkerei in Äthiopien & Indonesien stärken. Die ersten Prototypen wurden in beiden Ländern installiert. Das System dient Imker*innen & Wissenschaftler*innen als Überwachungs- und Forschungsinstrument und hilft Bienenzüchter*innen die Züchtungsauswahl detaillierter durchführen.

» Webseite: SAMS Smart Apiculture Management Systems
» Twitter: SAMS_EUproject_H2020

Kontakt: Angela Zur

Abstract of Monitoring of bees - first systems installed in Indonesia

SAMS, a project funded by the European Union's Horizon 2020 research and innovation program (GA No° 780755), aims to generate research data through the digital SAMS monitoring system. Evaluated data should include Enable conclusions to be drawn about bee health and productivity and strengthen beekeeping in Ethiopia & Indonesia. The first prototypes were installed in both countries. The system serves beekeepers and scientists as a monitoring and research tool and helps beekeepers to select breeding in greater detail.

1.3.2 June 2019, Pinboard Rural Development – Monitoring of bees - first systems installed in Indonesia

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Ausgabe Nr. 216 | Juni 2019

Ländliche Entwicklung Newsletter

Monitoring von Bienen – erste Systeme in Indonesien installiert

Regionalbüro Süd - EU H2020 Projekt SAMS als Teil des IZR-Vorhabens Innovationswerkstatt

SAMS Logo
©GIZ/UNPAD

Das internationale Imkerei-Projekt SAMS (*Smart Apiculture Management Services*) zielt darauf ab, mithilfe eines Monitoringsystems Forschungsdaten unter anderem über Bienengesundheit und -produktivität zu liefern und die Honigwirtschaft in Äthiopien und Indonesien zu stärken. Im März und April 2019 wurden hierfür die ersten Prototypen in Indonesien sowie Äthiopien installiert. Ein Wabenrähmchen ist dabei mit einer Überwachungseinheit inklusive Sensorik ausgestattet, sodass Daten direkt in der Beute generiert werden. Zusätzlich wird eine Waage unter der Beute installiert, um das Gewicht des Bienenstocks zu messen und Imker/innen über Veränderungen informieren zu können. Alle Sensoren werden über eine *Smartphone App* eingerichtet und kalibriert.

Das SAMS Monitoringsystem könnte in Zukunft nicht nur Imker/innenn und Wissenschaftler/innen ein wichtiges Instrument für Überwachung und Forschung bieten, sondern auch Bienenzüchter/innen könnten die Züchtungsauswahl anhand verschiedener Parameter detaillierter durchführen. Die gesammelten Daten können zusätzlich auch für weitere Forschungsdisziplinen von Relevanz sein und sollen deshalb offen bereitgestellt werden. Das Projekt SAMS wird aus Mitteln des Forschungs- und Innovationsprogramms *Horizon 2020* der Europäischen Union unter GA 780755 finanziert.

Kontakt:
Angela Zur

Weitere Informationen:
SAMS-Website
SAMS (Twitter)
SAMS-Quartalnewsletter
Regionalbüro Süd

SAMS Monitoring Hive/ System
©Sascha Fiedler/Universität Kassel

Abstract of Monitoring of bees - first systems installed in Indonesia

SAMS is funded by the European Union's Horizon 2020 research and innovation program (GA 780755) and aims to use a monitoring system to generate research data that, among other things, provide information on bee health and productivity and should strengthen beekeeping in Ethiopia & Indonesia. The collected data can also be of relevance for other research disciplines and should therefore be made available openly. In March 19 and April 19, the first prototypes of the monitoring system were installed in Indonesia and Ethiopia. A honeycomb frame is equipped with a monitoring unit including sensors so that data is generated directly in the hive. In addition, scales will be installed under the hive to measure the weight of the beehive and to inform the beekeeper of any changes. All sensors are set up and calibrated using a smartphone app.

In the future, the SAMS monitoring system could not only offer beekeepers & scientists an important tool for monitoring & research, but also beekeepers could carry out the selection of breeds in more detail based on various parameters.

1.3.3 March 2020, Pinboard Rural Development – Monitoring of bees - development of a data warehouse and decision support system

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Ausgabe Nr. 219 | März 2020

Ländliche Entwicklung Newsletter

Monitoring von Bienen – Entwicklung eines *Data Warehouse* und *Decision Support Systems*

OE 3920 RB Süd – EU H2020 Projekt SAMS – *Smart Apiculture Management Services* als Teil des IZR–Vorhabens Innovationswerkstatt

SAMS Smart Apiculture Management Services

SAMS Logo
©GIZ/UNPAD

Das Imkerei-Projekt SAMS – *Smart Apiculture Management Services* – liefert mithilfe eines Monitoringsystems Forschungsdaten über Bienengesundheit und -produktivität und soll dazu beitragen, die Honigwirtschaft in Äthiopien und Indonesien zu stärken. 2019 wurden in Indonesien und Äthiopien die ersten Prototypen des durch das Forschungs- und Innovationsprogramm Horizon 2020 der Europäischen Union (GA 780755) finanzierten internationalen Projekts installiert. Nach *User Centred Design Workshops* erfolgte die Anpassung des Monitoringsystems an die Bedarfe der Nutzer*Innen vor Ort. Weitere Adaptionen fanden seither kontinuierlich statt und die angepassten Monitoringsysteme werden nach und nach, flankiert durch *Capacity Building*-Maßnahmen in Indonesien und Äthiopien, implementiert.

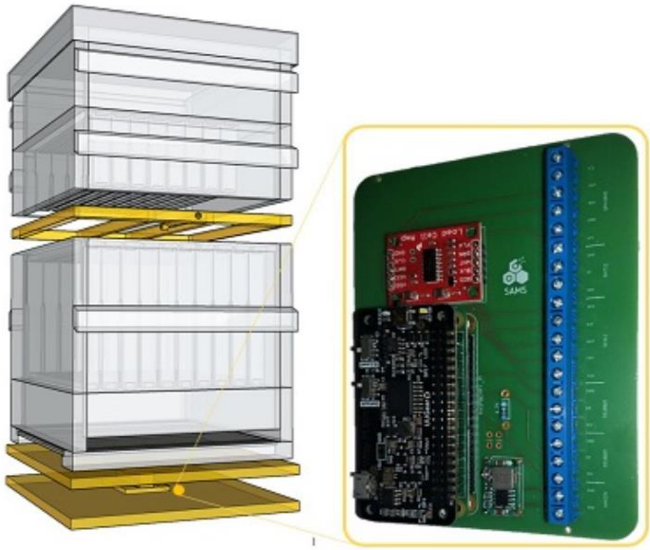
Das Monitoringsystem besteht aus diversen Sensoren, die Temperatur, akustische Signale und Gewicht des Bienenschwarms aufnehmen. Es wird an einem Rahmen im Inneren des Bienenkastens platziert, sodass die Daten direkt im Bienenkasten generiert werden. Alle Sensoren werden über eine *Smartphone-App* eingerichtet und kalibriert.

Die über das Monitoringsystem generierten Daten werden an das *SAMS DataWarehouse* (DW) übermittelt. Sie werden analysiert und interpretiert, um das geplante *Decision-Support-System* (DSS) zu speisen. Das DSS übermittelt den Endnutzer*innen (Imker*Innen) Hinweise zur aktuellen Gesundheit ihrer Bienen und liefert nach Bedarf Optimierungsvorschläge für das Bienenmanagement.

Neben der Entwicklung des *Monitoring-* und *Decision-Support Systems* werden Geschäftsmodelle durch lokale *Stakeholder* erstellt, um entlang der gesamten Wertschöpfungskette Einkommensquellen zu generieren.

Kontakt:
Stefanie Schädlich

SAMS-Website
SAMS-Quartalnewsletter
SAMS auf Twitter
Mehr Informationen zum Regionalbüro Süd finden Sie hier.



SAMS *Monitoring Hive/System*
©Sascha Fiedler, Universität Kassel

Abstract of Monitoring of bees - development of a data warehouse and decision support system

The international beekeeping project SAMS - Smart Apiculture Management Services, funded by the European Union's Horizon 2020 research and innovation program (GA 780755) aims to use a monitoring system to provide research data on, among other things, bee health and productivity and the honey industry in Ethiopia and To strengthen Indonesia. In 2019 the first prototypes were installed in Indonesia and Ethiopia. After user-centered design workshops, the monitoring system was adapted to the needs of the users on site. Further adaptations have taken place continuously since then and the adapted monitoring systems are gradually being implemented, flanked by capacity building measures in Indonesia and Ethiopia.

The monitoring system consists of various sensors that record the temperature, acoustic signals and weight of the swarm of bees. It is placed on a frame inside the beehive so that the data is generated directly in the beehive. All sensors are set up and calibrated using a smartphone app.

The data generated by the monitoring system is transmitted to the SAMS DataWarehouse (DW). They are analyzed and interpreted in order to feed the planned decision support system (DSS). The DSS provides the end users (beekeepers) with information on the current health of your bees and, if necessary, provides suggestions for optimizing the management of the bees.

In addition to developing the monitoring and decision support system, business models are created by local stakeholders in order to generate sources of income along the entire value chain.

1.3.4 May 2020 – Latvian Newspaper Zemgale Zinas – LLU zinatnieki attalinati vac datus par izmainam bisu stropos

4 ZEMGALES ZIŅAS ZIŅAS www.zz.lv 2020. GADA 7. MAIJĀ

LLU zinātnieki attālināti vāc datus par izmaiņām bišu stropos

Rozā krāsā mēdz būt ne tikai leļļu mājas, bet arī bišu stropi Latvijas Lauksaimniecības universitātes (LLU) Dārzkopības un apiloģijas nodaļā. Kamēr bitēm bija ziemas miegs, informācijas tehnoloģiju pētnieki nesnauda un attālināti vāca datus par izmaiņām stropos. Viņu programmētās monitoringa sistēmas izmanto Indonēzijas un Etiopijas biškopji, bet tehnoloģiju prototipus pētnieki testē tepat Jelgavā.

Tas viss notiek projektā "Starptautiskā partnerība uz inovācijās bāzētiem pārvaldības pakalpojumiem viedajā biškopībā" jeb SAMS (International Partnership on Innovation in Smart Apiculture Management Services).

Jau no 2018. gada LLU zinātnieki piedalās starptautiskā "Apvārsnis 2020" projektā SAMS, kura mērķis ir stiprināt starptautisko sadarbību starp Eiropas Savienības un jaunattīstības valstīm Etiopiju un Indonēziju informācijas un komunikācijas tehnoloģiju jomā, koncentrējoties uz ilgtspējīgu lauksaimniecību, konkrēti – uz precīzo biškopību.

Precīzā biškopība, kā to definējis LLU Informācijas tehnoloģiju fakultātes vadošais pētnieks inženierzinātņu doktors Aleksejs Zacepins savā promocijas darbā, ir "dravas vadības stratēģija, balstoties uz individuālas bišu saimes uzraudzību, ar mērķi minimizēt bišu saimes resursu patēriņu un maksimizēt bišu produktivitāti". Lai veiksmīgi realizētu precīzo biškopību, ir nepieciešams ieviest bišu saimju uzraudzības sistēmas, ar kuru palīdzību tiks nodrošināta datu par bišu saimēm attālināta savākšana.

Eiropā bišu uzraudzības sistēmas ir diezgan attīstītas un plaši izmantotas, bet Etiopijā un Indonēzijā tas ir kas jauns. Projekta dalībnieki cenšas uzlabot bišu saimju pārvaldības risinājumus minētajās valstīs, sākot ar pamata bišu turēšanas jautājumiem un beidzot ar automatizēto sistēmu izstrādi un ieviešanu.

A.Zacepins stāsta, ka projektā ir astoņi partneri un vadošais partneris ir GIZ (Deutsche gesellschaft fur internationale zusammenarbeit) no Vācijas.

LLU programmētās monitoringa sistēmas izmanto Indonēzijas un Etiopijas biškopji, bet tehnoloģiju prototipus pētnieki testē tepat Jelgavā

Latvijas kā partnera viens no projekta uzdevumiem ir izstrādāt tīmekļa datu noliktavas sistēmu, kas ļaus atspoguļot datus no bišu saimju uzraudzības sistēmas un arī ieviest datu analīzes moduļus, kas palīdzēs identificēt bišu saimes attīstības stāvokļus. Bišu saimes stāvokļu atpazīšanai var izmantot dažādus parametrus, bet projektā tiek strādāts galvenokārt ar svara un temperatūras mērījumiem. Pēc temperatūras datiem var secināt par bišu saimes bojāeju, spietošanu un perošanu, bet pēc svara datiem viegli iespējams secināt par nektāra vākšanas intensitāti. Datu noliktavas priekšrocība ir tāda, ka pie tās var pieslēgt ne tikai projektā izstrādātu aparatūru, bet arī citas uzraudzības sistēmas.

Būtisks ir arī sistēmas ekonomiskais aspekts, jo biškopji Etiopijā un Indonēzijā nevēlas ieguldīt daudz līdzekļu automatizētā uzraudzībā, tāpēc tiek strādāts pie dažādām sistēmas konfigurācijām, piedāvājot elastīgu funkcionalitāti, balstoties uz lietotāju prasībām un vajadzībām, skaidro A.Zacepins.

— *Andra Ozola*

FOTO: LLU

Abstract of the "Zemgales Zinas" newspaper article "LLU scientists remotely collects data about the changes in the beehives"

A local Latvian newspaper (Zemgales Ziņas) published a short summary about the SAMS project and remote bee colony monitoring. The article gives an introduction about the importance of precision beekeeping and its application in Indonesia and Ethiopia, where bee colony temperature and weight are being monitored. Alongside the monitoring system, the SAMS data warehouse for data storing and analysis is shortly described as well.

1.3.5 June 2020, Pinboard Rural Development – Opportunities and risks from Corona in the international ICT beekeeping project SAMS

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

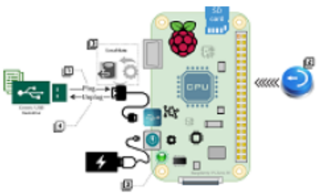
Ausgabe Nr. 220 | Juni 2020

Ländliche Entwicklung Newsletter

Pinboard Ländliche Entwicklung
Ein Service der Abteilung G500 / der Kompetenzcenter 4D20 und 4D30

Chancen und Risiken durch Corona im internationalen ICT-Imkerei-Projekt SAMS

OE 3920 RB Süd – EU H2020 Projekt SAMS – *Smart Apiculture Management Services* als Teil des IZR–Vorhabens Innovationswerkstatt



Wegen Problemen mit der Netzstabilität und häufigen Netzzusammenbrüchen hat das SAMS-Team eine bequeme Lösung für lokale offline Datenspeicherung durch Nutzung eines Flashdrives entwickelt. © LLU

Auch in einem internationalen Projekt, in dem regelmäßige Treffen über Videokonferenzen und digitales Arbeiten an der Tagesordnung sind, spürt man die Auswirkungen der Corona-bedingten Umstände stark.

Das Imkerei-Projekt SAMS – *Smart Apiculture Management Services* – liefert mithilfe eines Monitoringsystems Forschungsdaten über Bienengesundheit und -produktivität und soll dazu beitragen, die Honigwirtschaft in Äthiopien und Indonesien zu stärken. Hierzu arbeiten Partner aus Lettland, Österreich, Deutschland, Äthiopien und Indonesien seit Januar 2018 eng zusammen.

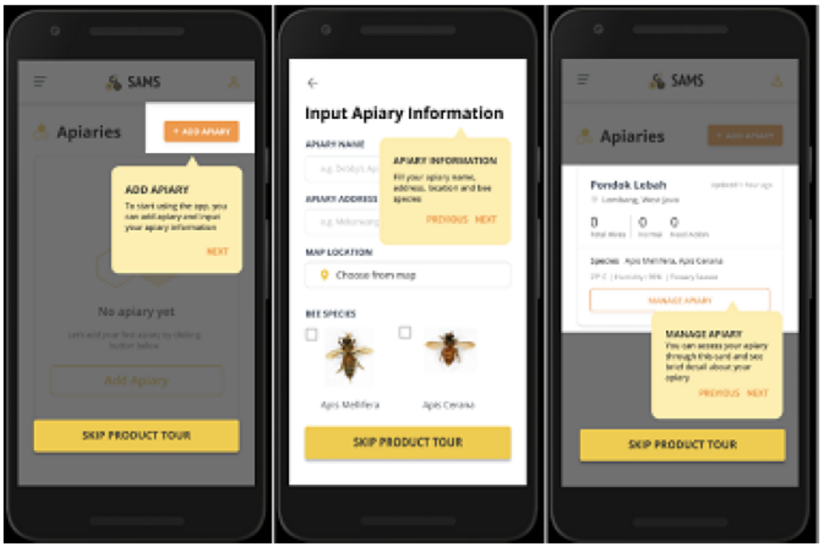
Nachdem im Jahr 2019 in den indonesischen und äthiopischen Projektregionen Bienenstöcke mit Monitoringsystemen ausgestattet worden sind, bereitet die Generierung und der Transfer von Daten Probleme, welche durch die Corona-Pandemie verstärkt werden. Durch Ausgangssperren und eine noch stärker eingeschränkte Infrastruktur wird das regelmäßige Kontrollieren der Bienenstöcke und der automatische Datentransfer beeinträchtigt. Für letzteres Problem konnte nun durch lokale Datenspeicher Abhilfe geschaffen werden. Mit dieser Strategie ist das Projekt allerdings auf ein häufigeres Besuchen der Testgebiete zur Datensammlung und Bienenstockkontrolle angewiesen – was in Zeiten von Ausgangssperren jedoch schwer umsetzbar ist.

Die parallel zur technischen Entwicklung laufenden Weiterbildungsmaßnahmen im Bereich Bienenmanagement und -gesundheit sowie *Business Design* in der Honigwertschöpfungskette mussten wegen Corona-Beschränkungen bis auf weiteres ausgesetzt werden.

Während auf Seiten der Hardware und der Weiterbildung logistische Probleme durch die Corona-Maßnahmen verstärkt werden, läuft die Entwicklung der Software weiter. Bei der Ausarbeitung des *Decision-Support-Systems* (DSS), welches Imker*innen Hinweise zur aktuellen Gesundheit ihrer Bienenvölker und, je nach Bedarf, Optimierungsvorschläge für das Bienenmanagement liefert, profitiert das Projekt von der internationalen digitalen Zusammenarbeit. Auf Basis der ersten Datensätze von überwachten Bienenkolonien konnte ein Datenverarbeitungsmodell entwickelt werden, das den Imker*innen die entsprechenden Informationen zu ihren Bienenstöcken liefert. Eine erste Version des *Decision-Support-Systems* ist den beteiligten Imker*innen nun online zugänglich. Nach dem digitalen Prinzip „*Design with the user*" durchläuft die Testversion eine Anwenderprüfung durch äthiopische und indonesische Imker*innen. Nach dieser Prüfung wird das *Decision-Support-System* nochmals, entsprechend der Bedarfe der Nutzer*innen vor Ort, angepasst.

Kontakt:
Stefanie Schädlich

Weitere Informationen:
SAMS-Website
SAMS auf Twitter
Mehr Informationen zum Regionalbüro Süd finden Sie hier.



Das neue Design des SAMS-*Decision-Support-Tools* für Imker*innen

Abstract of Opportunities and risks from Corona in the international ICT beekeeping project SAMS

Even in an international project, in which regular meetings via video conferences and digital work are the order of the day, the effects of the Corona-related circumstances can be felt strongly.

The beekeeping project SAMS - Smart Apiculture Management Services - provides research data on bee health and productivity with the help of a monitoring system and is intended to contribute to strengthening the honey industry in Ethiopia and Indonesia. For this purpose, partners from Latvia, Austria, Germany, Ethiopia and Indonesia have been working closely together since January 2018.

After beehives were equipped with monitoring systems in the Indonesian and Ethiopian project regions in 2019, the generation and transfer of data is causing problems that are exacerbated by the corona pandemic. The regular control of the beehives and the automatic data transfer are impaired by curfews and an even more restricted infrastructure. The latter problem has now been remedied by local data storage. With this strategy, however, the project relies on frequent visits to the test areas for data collection and beehive control - which is difficult to implement in times of curfews.

The further training measures in the field of bee management and health as well as business design in the honey value chain, which are running parallel to the technical development, had to be suspended until further notice due to corona restrictions.

While the corona measures intensify logistical problems on the hardware and training side, software development continues. The project benefits from international digital cooperation in the development of the Decision Support System (DSS), which provides beekeepers with information on the current health of their bee colonies and, if necessary, optimization suggestions for bee management. Based on the first data sets from monitored bee colonies, a data processing model was developed that provides beekeepers with the relevant information about their beehives. A first version of the decision support system is now available online to the beekeepers involved. According to the digital principle "Design with the user", the test version goes through a user test by Ethiopian and Indonesian beekeepers. After this check, the decision support system is adjusted again according to the needs of the users on site.

1.3.6 August 2020- Univeristy Kassel – Sensor-based research of bee colonies

Sensorgestützte Untersuchung von Bienenvölkern

Vers.-Nr.: **Betrieb: Am Sande** **Schlag: Auf der Hobestadt**

AGT & DITSL Dr. Sascha Kirchner, Sascha Fiedler

Versuchsbeschreibung

Bienengesundheit und nachhaltige Bienenhaltung sind Schlüsselfaktoren für eine erfolgreiche Landwirtschaft. Sinkende Bestäubungsleistung und Honigproduktion durch eine Verschlechterung der Bedingungen für Honigbienen gefährden nicht nur den Lebensunterhalt der Imker und Imkerinnen, sondern auch die weltweite landwirtschaftliche Produktion.

SAMS (International Partnership on Innovation in Smart Apiculture Management Services) ist ein von der Europäischen Union gefördertes Projekt innerhalb des Förderplans Horizon 2020-ICT-39-2016-2017 und besteht aus vier europäischen Partnern (Österreich, Lettland, zwei aus Deutschland), sowie Partnern aus Äthiopien und Indonesien. Das Projekt (https://sams-project.eu/) verbindet nachhaltige Landwirtschaft und moderne ICT-Lösungen (Information and Communication Technologies).

Im Rahmen des Projektes wird am Fachgebiet Agrartechnik in Witzenhausen an der Weiterentwicklung eines Bienenüberwachungssystems geforscht. Am Bienenversuchsstand werden dazu dauerhaft die akustischen Signale von Bienenvölkern mittels Hochleistungsmikrofonen aufgezeichnet. Die entwickelten Bienenüberwachungssysteme liefern Daten zu akustischen Frequenzspektren, Temperatur, Luftfeuchtigkeit und Gewicht der Bienenvölker. Imkerliche Routinekontrollen der Bienenvölker begleiten den Versuch. Die erhobenen Daten werden auf Zusammenhänge hinsichtlich auffälligen Bienenverhaltens analysiert und mit den Daten unserer Projektpartner in Äthiopien und Indonesien verglichen. Die gewonnenen Ergebnisse solle zur Weiterentwicklung des Bienenüberwachungssystems sowie in Kooperation mit unseren Projektpartnern der Universität Jelgava zur Entwicklung eines Entscheidungsunterstützungssystems für den Imker genutzt werden.

SAMS Smart Apiculture Management Services

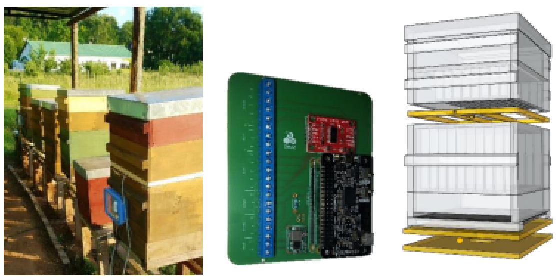


Abb.: Bienenstand mit Überwachungssystem

Sensor-based research of bee colonies

Bee health and sustainable beekeeping are key factors for successful farming. Declining pollination performance and honey production by worsening conditions for honeybees not only endanger the livelihood of beekeepers, but also worldwide agricultural production.

SAMS (International Partnership on Innovation in Smart Apiculture Management Services) is a project which received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement N° 780755 (2020-ICT-39-2016-2017) and consists of four European Partners (Austria, Latvia, two from Germany), as well as partners from Ethiopia and Indonesia. The project (https://sams-project.eu/) combines sustainable agriculture and modern ICT solutions (Information and Communication Technologies).

In the scope of the project, the research of the Agricultural Engineering Department in Witzenhausen focuses on further development of a bee monitoring system. Permanently high-performance microphones recording acoustic signals of the bee colonies bees at the test side. The developed bee monitoring systems provide data on acoustic frequency spectra, temperature, humidity and weight of the bee colonies. Along with the recording the beekeeper controls the bee colonies. The collected data is analysed to identify correlations of the data with conspicuous bee behaviour and compared the data with data from the project countries Ethiopia and Indonesia.

The results obtained should be used to develop the bee monitoring system as well as a decision support system in cooperation with the project partners of Jelgava University.

1.3.7 September 2020 – Citizien Science Conference – SAMS-Dezentrales Bienenvolkmonitoring in Äthiopien und Indonesien

The SAMS poster was presented at the Citizen Science Conference, which was held online. All conference posters, including ours including the German abstract are still available online.

Universität
Karl-Franzens-Universität Graz

Institut für Biologie

Naturwissenschaften

Registriert am 25. August 2020

MARKTPLATZ EINTRÄGE

POSTER

SAMS - Dezentrales Bienenvolkmonitoring in Äthiopien und Indonesien

Bienengesundheit und nachhaltige Bienenhaltung sind Schlüsselfaktoren für eine erfolgreiche Landwirtschaft. Abnehmende Honigproduktion, aber vor allem sinkende Bestäubungsleistung stellen damit nicht nur eine Herausforderung für Imker und Imkerinnen dar, sondern auch für die globale Landwirtschaft und die Weltbevölkerung.
SAMS (International Partnership on Innovation in Smart Apiculture Management Services) ist ein von der EU gefördertes Horizon 2020 Projekt (ICT-39-2016-2017) und macht sich zum Ziel mit Hilfe von modernen Open-Source-ICT-Anwendungen die Bienenhaltung zu optimieren, um die Ernährungssicherheit und höhere Einkommen anzustreben. Das SAMS-Konsortium besteht aus vier europäischen Partnern (Österreich, Lettland und zwei aus Deutschland), sowie Partnern aus den Zielländern Äthiopien und Indonesien.
Bürgerbeteiligung ist in Entwicklungsländern weniger weit verbreitet als in Europa oder Nordamerika. Gründe dafür sind das Fehlen von Freiwilligen und bei Untersuchungen, die technische Unterstützung benötigen, vor allem der Mangel an verfügbaren Geräten. In SAMS entwickeln und produzieren wir in Äthiopien und Indonesien vor Ort elektronische Systeme zur Überwachung von Bienenvölkern, die vor allem günstig und leicht zu handhaben sein sollen. Das SAMS-System soll den Imkern und Imkerinnen als Entscheidungshilfe dienen. Dabei werden Sensor-gestützte Datenausgaben mit anderen Informationsquellen und Vorhersagemodellen kombiniert, um so Rückschlüsse auf den Status der Bienenkolonien (Vitalität, Produktivität, etc.) zu geben. Der Benutzer wird dabei alarmiert, sobald die Daten vom Normalzustand abweichen. Die dezentralen, aber vernetzten Bienenvölker sammeln dabei Daten für die Wissenschaft. Ein weiterer wichtiger Projektteil ist die Erstellung von Geschäftsprozessen, die entlang der Wertschöpfungskette für Bienenprodukte entwickelt werden. Durch eigens auf die Endnutzer zugeschnittene Präzisions-Bienenhaltung werden der Ressourcenverbrauch minimiert, während die Produktivität maximiert wird, wovon sowohl Klein-Imkereien, als auch Großbetriebe profitieren. Um mehr über das Projekt zu erfahren, besuchen Sie unsere Projektwebseite: https://sams-project.eu/, oder unseren im Rahmen des Projektes erstellten Wiki: https://wiki.sams-project.eu/.

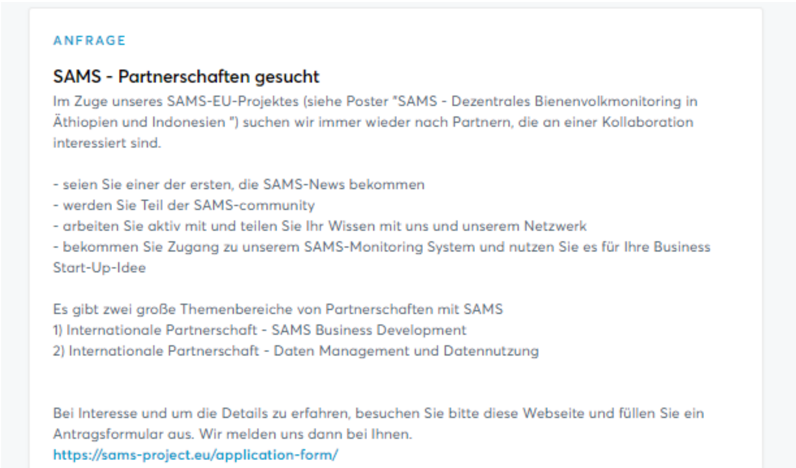
Angefügte Dateien

SAMS - Dezentrales Bienenvolkmonitoring in Äthiopien und Indonesien

Abstract of "Decentralized bee monitoring in Ethiopia and Indonesia" (first screenshot) and call for partnerships (second screenshot)

UNIGRA presented the SAMS poster at the Citizen Science conference 2020, which was, due to the corona pandemic, held online. In addition to the poster, we provided an abstract in German language that summarizes the SAMS project itself with the aim of developing a bee monitoring system as well as its advantages for the users. We also mentioned the project website and the SAMSwiki. This abstract as well as the call for partnerships (second screenshot) are still online at their website linked in the headline.

Second following screenshot shows: call for partners at the conference's "marketplace". This posting is also still online.


ANFRAGE

SAMS - Partnerschaften gesucht

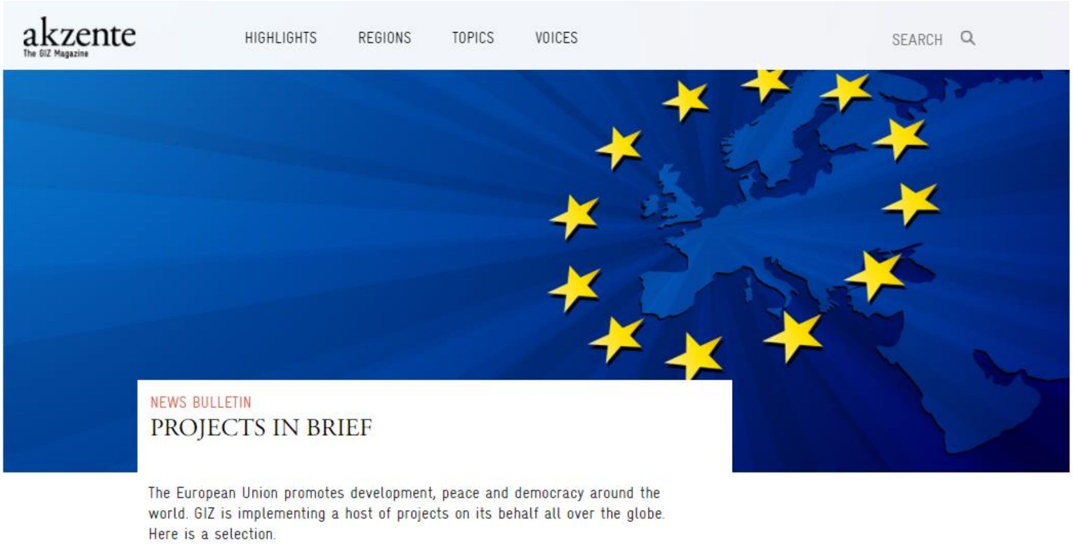
Im Zuge unseres SAMS-EU-Projektes (siehe Poster "SAMS - Dezentrales Bienenvolkmonitoring in Äthiopien und Indonesien ") suchen wir immer wieder nach Partnern, die an einer Kollaboration interessiert sind.

- seien Sie einer der ersten, die SAMS-News bekommen
- werden Sie Teil der SAMS-community
- arbeiten Sie aktiv mit und teilen Sie Ihr Wissen mit uns und unserem Netzwerk
- bekommen Sie Zugang zu unserem SAMS-Monitoring System und nutzen Sie es für Ihre Business Start-Up-Idee

Es gibt zwei große Themenbereiche von Partnerschaften mit SAMS
1) Internationale Partnerschaft - SAMS Business Development
2) Internationale Partnerschaft - Daten Management und Datennutzung

Bei Interesse und um die Details zu erfahren, besuchen Sie bitte diese Webseite und füllen Sie ein Antragsformular aus. Wir melden uns dann bei Ihnen.
https://sams-project.eu/application-form/

1.3.8 October 2020 – Akzente Magazin – supporting beekeeping



akzente
The GIZ Magazine

HIGHLIGHTS REGIONS TOPICS VOICES SEARCH

NEWS BULLETIN

PROJECTS IN BRIEF

The European Union promotes development, peace and democracy around the world. GIZ is implementing a host of projects on its behalf all over the globe. Here is a selection.

akzente
The GIZ Magazine

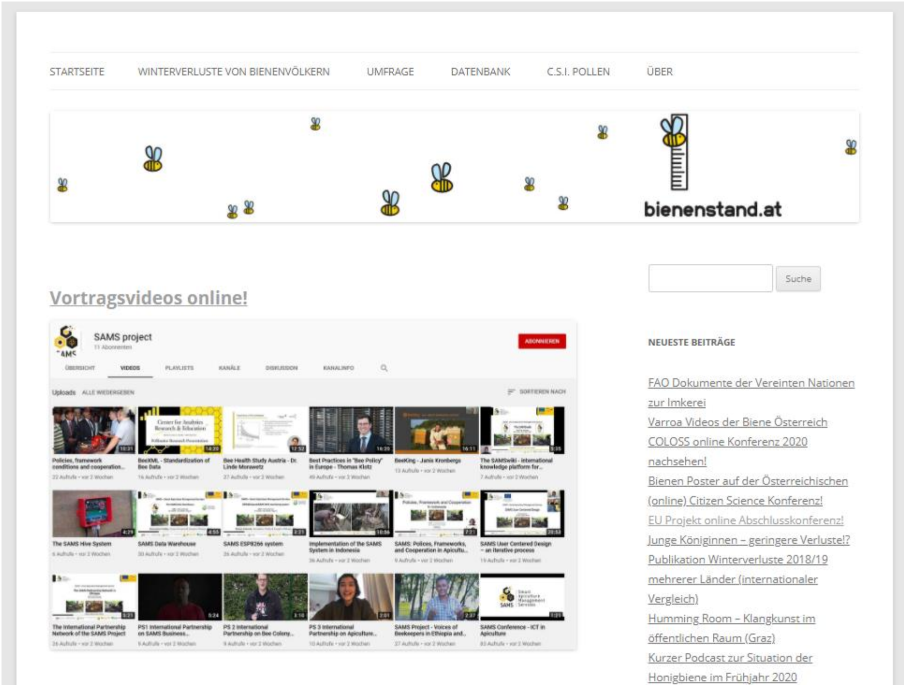
HIGHLIGHTS REGIONS TOPICS VOICES SEARCH

Supporting beekeeping

GLOBAL Beekeeping plays a key role in conserving our ecosystem, combating hunger worldwide and guaranteeing our future survival. Digital tools can make a major contribution to strengthening the sector's position. This is where the Smart Apiculture Management Services project (SAMS) comes in. The project is coordinated by GIZ, with funding from the European Union's Horizon 2020 research and innovation programme (GA No. °780755). The focus is on developing a modular monitoring system for beehives tailored to the local situation in Ethiopia and Indonesia, and implementing a cloud-based system that offers beekeepers advice and support with decision-making. This will not only strengthen the sector but also identify potential for innovation along the value chain and support a range of stakeholder groups, including women, in earning a living.

1.3.9 December 2020 – SAMS on Bienenstand

Bienenstand.at was mentioning the SAMS project several times in the past years. In December the website informed that the SAMS final conference videos are accessible online: http://bienenstand.at


STARTSEITE
WINTERVERLUSTE VON BIENENVÖLKERN
UMFRAGE
DATENBANK
C.S.I. POLLEN
ÜBER
bienenstand.at
Vortragsvideos online!
SAMS project
Suche
NEUESTE BEITRÄGE
FAO Dokumente der Vereinten Nationen zur Imkerei
Varroa Videos der Biene Österreich
COLOSS online Konferenz 2020 nachsehen!
Bienen Poster auf der Österreichischen (online) Citizen Science Konferenz!
EU Projekt online Abschlusskonferenz!
Junge Königinnen – geringere Verluste!?
Publikation Winterverluste 2018/19 mehrerer Länder (internationaler Vergleich)
Humming Room – Klangkunst im öffentlichen Raum (Graz)
Kurzer Podcast zur Situation der Honigbiene im Frühjahr 2020

2. Publications

2.1 August 2018 – The Api News – Newsletter of the Ethiopian Apiculture Board

The API News

The API News is a quarterly sector newsletter published by the ETHIOPIAN APICULTURE BOARD

Volume 5 Number 3, August 2018

Beekeeping for Environment Conservation and Enhancing Rural Livelihood - A joint EAB and EU Support to GIZ-SLMP Pilot Project (Contributed by Talila Keno, Email: talila.keno@gmail.com)

Honey & Beeswax analyses cont…

Table 2: Information on honey and beeswax parameter analysis cost

2.1 Honey

S/ no	Parameter	Unit price (ETB)
1	Colour	50
2	Moisture content	80
3	Electrical conductity	100
4	PH	100
5	Free Acidity	100
6	Ash content	100
7	HMF	150
8	Sucrose	250
9	Fructose	250
10	Glucose	250
11	Maltose	250
12	Pollen	100

2.2 Beeswax

S/ no	Parameter	Unit price
1	Melting point	100

============//============

SAMS-International Partnership on Innovation in Smart Apiculture Management Services (Contibuted by Kibebew Wakjira, wkibebew@gmail.com)

Background

SAMS is a consortium project comprising of two partners each from Ethiopia, Germany and Indonesia and one partner each from Austria and Latvia. The project is funded by the European Union within the H2020-ICT-39-2016-2017 call and it addresses the UN Sustainable Development Goal *"End hunger, achieve food security and improved nutrition and promote sustainable agriculture"*. To this end, SAMS proposed the implementation of "Precision Apiculture" by allowing active monitoring and remote sensing of bee colonies and beekeeping by developing appropriate ICT solutions supporting management of bee health and bee productivity. Bee health and sustainable beekeeping are key for sustainable agriculture worldwide. Risks of depleting honey production threatens livelihoods of beekeepers, but degradation of pollination power of suffering bee colonies threats overall agricultural production and affects the entire population. Advanced ICT and remote sensing technology in SAMS increases production of bee products, and creates jobs (particularly for youths and/women), triggers investments, and establishes knowledge exchange through networking. Towards these, SAMS tries to address requirements of end-user communities on beekeeping in project countries. The overall goal is to have the beekeeping contexts of Ethiopia and Indonesia identified, manuals on hive construction and hive operation developed and knowledge exchange networks established. As a final outcome, the project intends to create:

a) A physical low-cost beehive model, which is locally produced and adapted to local conditions, including integrated open source sensor and information transition technology, as well as energy-supply solution;

b) A decision support system that combines the sensor-based data-outputs with other information sources and predictive models to measure, analyse and describe different states of the bee colony such as health, vitality, production, etc.;

c) An automatic advisory support tool, which will alert the beekeeper in an easily understandable way if any aberrations from normal states are metered and will provide advice on appropriate countermeasures;

d) A bee management business concept for the local production and up-scaled implementation of the developed beehives with integrated beehive monitoring system.

Dissemination and exploitation of results

SAMS focuses on providing an accessible, acceptable, affordable bee management system, which combines the requirements of the target group with up-to-date technology. A central question to be addressed through this project is how to reach and convince local communities, farmers and beekeepers. Participants' existing expertise and the new insights, particularly the regional requirements gained in this project's work packages, will be used directly to ensure an easy to use ICT system of high quality and high relevance. Ultimately this project aims to significantly increase the number of beekeepers that adopt modern beehives together with modern technology, making use of their consisting potential in the beekeeping sector. The SAMS strategy for dissemination and exploitation of projects results takes into account:

- Reaching various target groups among the value chain by establishing of local advisory boards for guiding and developing communication mechanisms,
- Developing business plans for future SAMS enterprises and availing manual on new HIVE system construction and operation combined with capacity building program,
- Approaching beneficiaries for facilitating learning and adoption of knowledge in practice through workshops, educational trainings and conferences during the project time

All manuals, concepts, transfer studies and other deliverables will be available for free download from the project website in English. Part of these deliverables, particularly the manuals, will be translated into Amharic and other languages required by local stakeholders. International transfer of acquired knowledge and experiences will be based on (i) establishing international partnerships, (ii) developing transferability studies, (iii) performing training, workshops and conferences, (iv) closed interaction with established networks, as well as (v) international surveys with research institutions, beekeeper associations, facilitators, agri - entrepreneurs, market participants and other SAMS data beneficiaries.

Technology and level of readiness

The technologies which will be adapted in the SAMS project are based on technologies developed in the EU program ICT-AGRI-2 within FP 7 by the project "ITApic". The Apiary Sensor Unit (ASU) will be based on the system prototype developed by the University of Kassel, which was tested and demonstrated in an operational environment (TRL 7). It consists of a Raspberry Pi 3 based measurement unit (B) with integrated open source recording and data processing software combined with an off-grid power supply based on solar energy (A)

Continue reading on the next page

The views expressed in the articles are those of the authors and not necessarily those of the EAB 4

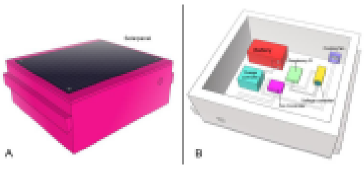


Figure 1: University of Kassel Apiary Sensor Unit (ASU) unit with solar panel on the outside (A) and power supply, measuring and cooling components on the inside (B).

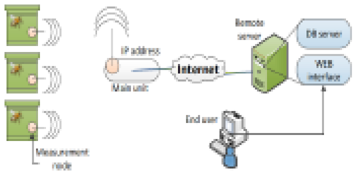
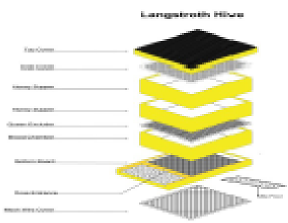


Figure 2: Architecture of the temperature monitoring and DSS system.

The project will propose which hive frame system will be most suitable for different users in different countries (such as Langstroth, Zander, Dadant..) considering the predominantly used model as well as the prevailing bee races in the partner countries. Qualified local enterprises will be identified for producing the hives, and the available options will be considered (for instance timber – imported or local - , bamboo, foam or PU etc.). All frame hives follow the same set-up (see picture below) but have different dimensions. Honey supers could have different measurements (half size) in order to consider specific harvesting periods / flora types in selected areas.

Frame hives such as Langstroth made from timber fitted with available compo-nents are available for a reasonable price in our country. Frame hives with Zander measurements have also been produced in Ethiopian using polyure-thane foam. Solar panels, batteries, Raspberry Pi / Smart phones and sen-sors are also available.



Completely assembled frame bee-hive (sketch)

These sensors are used for the measurements of temperature, humidity and other weather data; acoustics (audio and video) and for several stages of a colony: swarming, brood - less stage, brood rearing, hive weight, diseases.

Data transfer to the server needs to be determined but could be via GSM network, and then by Wifi or USB sticks once the data reach the IP address main unit (Figure 2).

Once the methodology is developed, there must be capacity building (including manuals for the finished system) and the establishment of start - ups.

Expected technological Impact of SAMS

* Higher rate of organization of beekeepers to increase impact on markets (economy of scales) and government (legislative and funding).

* Interconnection with stakeholders along value chain, especially farmers and bee-products processor (mostly big companies), regarding smart and intelligent coordination of agri- and apicultural activities o bee-health and establishment of optimal processing/ marketing chains.

* New and open trade regulations between Indonesia and the EU.

* Easy to use and access to services/ tools to make beekeeping more efficient and more attractive to young people

The final outcome of the project will be a technologically enhanced beehive system and services including the following main components:

-A physical low-cost **beehive model**, that is locally produced and adapted to local conditions, including integrated open source sensor and information transition technology, as well as energy-supply solution;

-A **decision support system** that combines the sensor-based data-outputs with other information sources and predictive models to measure, analyse and describe different states of the bee colony such as health, vitality, production, etc.;

-An **automatic advisory support** tool, which will alert the beekeeper in an easily understandable way if any aberrations from normal states are metered and will provide advice on appropriate countermeasures. The response unit will support the user to avoid losses and to increase the profitability and stability of beekeeping;

-A **bee management business concept** for the local production and up-scaled implementation of the developed beehives with integrated beehive monitoring system.

The dissemination strategy is part of the research work in the UCD part of the work package.

"ASPIRE helps me to expand my beekeeping venture"

A case study from Amhara Region

(contributed by Kerealem Ejigu, e_kerealem@yahoo.com)

Eyayu Achamyeleh started beekeeping when he was 14 years old by purchasing one honeybee colony from his locality with Birr 70. Currently, having 17 years of experience in the field of beekeeping, 31-year-old Eyayu is one of the successful young beekeepers in Chan Diba kebele, Chilga woreda of Amhara region.

Ato Eyayu Achamyelew

He is also a resource person in the field whose services are utilized by 7 follower beekeepers out of which 2 are females and a Farmers Training Center for offering practical training, honeybee colonies transferring and honey harvesting.

He said that "before he got practical training with the ASPIRE project, he maintained 9 honeybee colonies (6 in local hives and 3 in frame hives) and managed the colonies in the traditional manner. As a result the total annual crude honey produced was not satisfactory, ranging from 30 to 40 kilograms". Fortunately he has got the ASPIRE minimum training package and the ASPIRE project model beekeepers training. During the training he was equipped with protective clothing and basic beekeeping equipment. protective clothing enables him to work with.

The views expressed in the articles are those of the authors and not necessarily those of the EAB 5

2.2 October, 2018 – Book of Proceedings – Agrosym Symposium

Proceedings of the IX International Agricultural Symposium "Agrosym 2018"

APPLICATION OF LORAWAN TECHNOLOGY IN PRECISION BEEKEEPING

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[1]Department of Computer Systems, Faculty of Information Technologies, Latvia University of Life Sciences and Technologies, Jelgava, Latvia
[2]LLC Lattelecom, Riga, Latvia
*Corresponding author: aleksejs.zacepins@llu.lv

Abstract

Beekeeping is an important production branch of the agriculture and honeybees are one of the main pollinators in the world. Therefore, for the beekeepers it is crucial to have information about the state of the bee colonies. Application of information technologies in the beekeeping lead to the foundation of the Precision Beekeeping. Precision Beekeeping is based on constant data collection of bee colonies, where collected data should be transferred to a remote data centre for further data analysis. Data transmission in the field of beekeeping sometimes can be a challenging task, because beehives can be placed in rural areas without the option to get constant power supply and Internet connection. Authors of this paper chose LoRaWAN technological solution, as it allowed low energy consumption devices to communicate with Internet-connected applications over long range wireless connections for many years with only one battery. LoRaWAN network coverage and sensors were provided by Latvian company Lattelecom. Three bee colonies were equipped with LoRaWAN enabled temperature sensors. Measurements from sensors were transmitted to the LoRaWAN network gateways and servers and access to collected data was provided through the Lattelecom IoT portal web application. This research was carried out within the Horizon 2020 project SAMS "Smart Apiculture Management Services", proposing implementation of Precision Beekeeping by allowing active monitoring and remote sensing of bee colonies and beekeeping by developing appropriate ICT (Information and Communication Technologies) solutions supporting management of bee health and bee productivity.

Keywords: *Precision Beekeeping, LoRaWAN technology, Bee colony monitoring, Internet of Things.*

Introduction

In recent years fast development of Internet of Things (IoT) allows to collect data about various objects, including monitoring of living objects (Li et al. 2015). Data collection is the first stage also in the Precision Agriculture (Terry 2006) and it's branches like Precision Beekeeping (PB). Precision Beekeeping is an apiary management strategy based on the monitoring of individual bee colonies to minimise resource consumption and maximise the productivity of bees (Zacepins et al. 2015). For the data collection in Precision Beekeeping different sensors and technologies can be used (Meikle & Holst 2014). One of the issues in data collection in PB is data transfer from monitored object to the remote database or data warehouse for data storage and further analysis. As beehives usually are placed outside the urban areas, in deep forests or in rural locations, therefore connection to convenient data transmission networks (Wi-Fi, mobile networks) are limited or sometimes unavailable, as well 220V power supply for measurement devices can be unavailable. Therefore, there is a need of a new data transmission technology, which can transfer data for a long range and with low power consumption. One of the available options is to use LoRa (Long Range) technology.
LoRa stands for Long Range LPWAN (Low Power Wide Area Network) signal modulation technology proposed by Semtech (Georgiou & Raza 2017). LoRaWAN is a long-range, low-power, low-bitrate, wireless telecommunications network protocol specification, developed by

1759

the LoRa Alliance, which uses LoRa signal modulation and is an infrastructure basis for the implementation of IoT solutions (Augustin et al. 2016). Together with long battery life, coverage is one of the most important features of the LoRaWAN solutions. Potentially communication range can achieve 10-15 km for outdoor coverage (Petäjäjärvi et al. 2016; Seye et al. 2017). Despite the potential of this technology it is not widely spread and used (Raza et al. 2016). Figure 1 below conceptually compares several data transmission technologies:

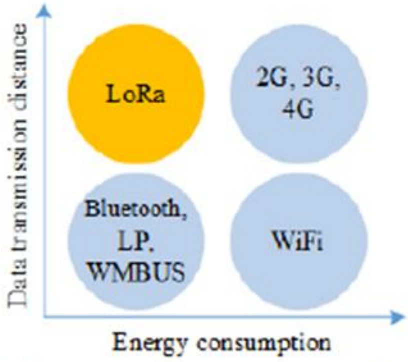

Figure 9. Comparison of data transmission technologies

Regarding agriculture sector, LoRaWAN also has huge potential. There are researches about possible implementation of that technology, for example implementation of smart irrigation (Zhao et al. 2017), soil parameter measurements (Xue-fen et al. 2017), but authors of this paper were not able to find any effort to use LoRaWAN in the beekeeping sector.

To use LoRaWAN technology it is possible to develop own infrastructure or use existing one. Many big telecommunication companies in the world provide such service, for example, Bouygues France telecommunications company has introduced LoRaWAN in 2015 and now more than 80% of the France territory is covered (http://www.objetconnecte.com/tout-savoirreseau-LoRa-bouygues). For author's research LoRaWAN infrastructure developed by Latvian company Lattelecom (https://iot.lattelecom.lv/) is used with main aim to evaluate the possibility to use it for Precision Beekeeping needs.

The Lattelecom group provides IT, telecommunication and outsourced business process solutions. Lattelecom Group is made up of five companies - SIA Lattelecom, Lattelecom BPO, Citrus Solutions and Lattelecom Technology with its subsidiary Baltic Computer Academy. The Lattelecom Group is the leading provider of electronic communications services in Latvia that offers electronic communication solutions for home, small and medium size businesses, state and municipal institutions, as well as for corporate clients.

In year 2017, Lattelecom started to develop LoRaWAN network and now is offering IoT services for municipalities and businesses for reading the utility meters, monitoring the utility infrastructure, controlling the street lights and etc. Advantages of Lattelecom network are:

- Lower cost comparing to WMBUS or 3G network;
- Low energy consumption;
- Huge amount of end devices supported by one gateway;
- Wide network coverage;
- Data transmission speed from 0.3 to 50 kbit/s.

To this moment LoRaWAN network is not covering the whole country, but is available in main cities. The capital Riga (which holds 32% of the population of Latvia, based on EUROSTAT Urban audit) has almost 99.9% network coverage (see Figure 2):

Figure 10. Lattelecom network coverage in Latvia
(source: https://www.lattelecom.lv/piedavajumi/iot/)

Concept of LoRaWAN working principle is demonstrated in Figure 3. End devices (sensors) are equipped with LoRa radio chip for a long-range data transmission. End nodes are communicating with gateways, which are connected to the Internet by the modern communication means (like fibre optics, or fast mobile internet). Those gateways are sending sensor data to the remote cloud based network server. Then developed Web application get data from the network sever to demonstrate it to the end user by the means of reports and data summaries.

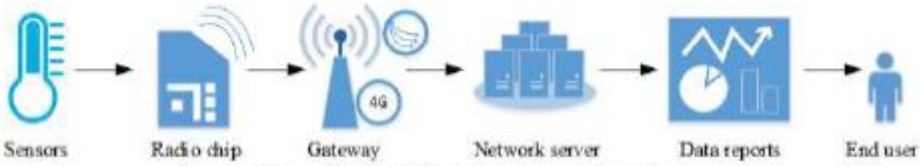

Figure 11. LoRaWAN working principle

Regarding Precision Beekeeping, there are several bee colony monitoring system architectures described (Kviesis & Zacepins 2015), in LoRaWAN scenario, each beehive (measurement node) is directly transferring the measurement data to remote network server and application using the gateway as a mediator.

Materials and methods

Based on the overall statistics beekeepers are not experienced IT specialists (not all of them), that's why installation of measurement system (measurement nodes) should not be complicated and should be done with little or no knowledge of IT. In author's case, installation of LoRa temperature sensor is trivial and user friendly – user only needs to put the sensor in the hive and mount the node to the beehive.

For authors research 3 (three) hives of *Apis mellifera mellifera* were equipped with temperature sensors for colony monitoring. Bee colonies were placed in an open environment under a hood (see Figure 4):

Figure 12. Placement of the beehives

The experiment took place at Strazdu iela 1, Jelgava, Latvia (N 56, 390, 4500 and E 23, 450, 1500). Sensors were installed on April 10, 2018. Norwegian-type hive bodies made of wood with external size 470 x 470 x 270 mm and internal size 380 x 380 x 270 mm, with a wall thickness of 45 mm, were used in the experiment. Sensors used were Adeunis Temp (see Figure 5) with references: ARF8181BA, ARF8180BA, ARF8181FA (source: https://www.adeunis.com/en/produit/temp/)).

Figure 13. Sensor Adeunis Temp

The temperature was measured every 10 minutes and data was transferred to a remote application. One temperature sensor per hive was placed above the hive body covering polyethylene foil as proposed by Stalidzans and Berzonis (Stalidzans & Berzonis 2013). Measurement units were mounted to the beehives as demonstrated in Figure 6:

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Figure 14. Beehives with mounted measurement units

Distance from the measurement point to the LoRaWAN gateway was approx. 2.4 km by the air in urban area (different obstacles, houses, trees, etc., see Fig. 7.). As a gateway Multitech MultiConnect Conduit with external antenna Taoglas OMB.868 is used.

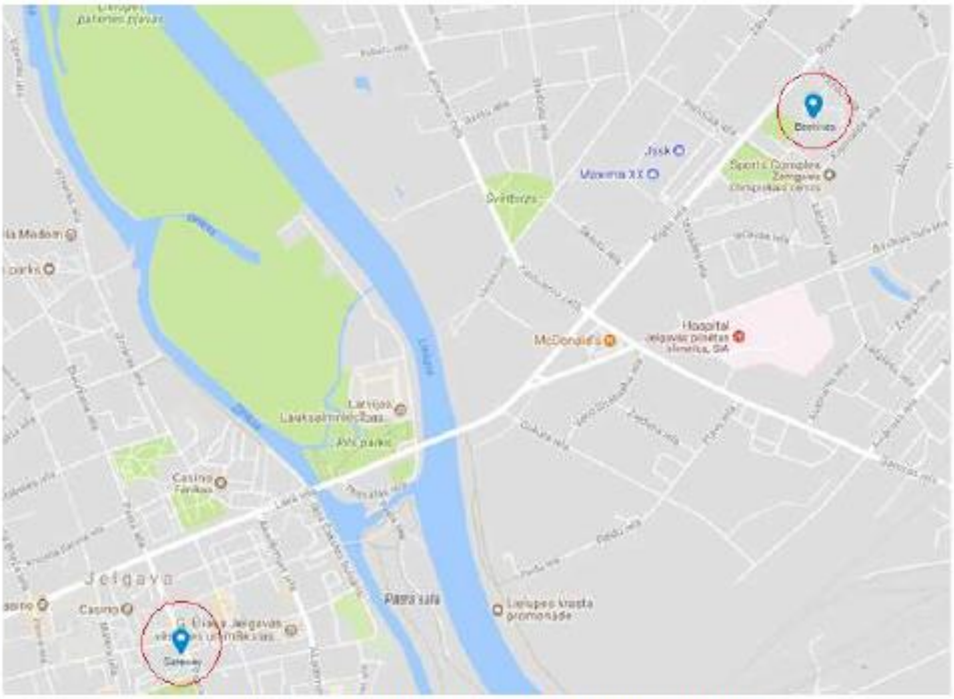

Figure 15. Location of beehives and gateway on the map

Web system for measurement visualisation

Bee colony temperature measurement data can be accessible using a Web based application (system). Web system is developed and provided by Lattelecom and is accessible by the address: https://iot.lattelecom.lv/portal/login. To get access to the measurement system administrator should register a new user and provide authorisation information (login and temporary password). After log in user can see his measurement objects (see Figure 8) and using pre-defined time periods (current month with 1 day step, last 7 days with 1 hour step,

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last 24 hours with 15 min step or create custom time period) it is possible to visualise measurement data.

Figure 16. Screenshot of the web system

In addition, user can view all measurement data in table format and copy it if needed.
Usage of described above Web system is not the only option. It is possible to get access to the data warehouse and create individual system for data visualisation and analysis. This option is considered in case if more functionality is needed, for example implementing custom data analysis algorithms it is possible to define various bee colony states (death, swarming, brood rearing, etc.) and inform the beekeeper when manual inspection of bee colony is needed.

Results and Discussion

Aim of this research was to test LoRaWAN network for implementation of Precision Beekeeping. Practical experiments shows, that data transfer from the experiment beehives to the LoRa gateway was completed successfully without interruptions during the whole experiment. As distance was 2.4 km, open question is how data transfer will operate on longer distances. Within this research authors used already available infrastructure from local telecommunication company Lattelecom, but development of own infrastructure is possible too, by installing own LoRa gateways. Open question for discussion – is it economically feasible to develop own infrastructure or it is better to use existing one. This should be evaluated in each scenario and each country individually. Application of LoRa sensor for bee colony temperature monitoring is theoretically possible, but taking into account economic aspects is not so attractive, because of the measurement unit price, which is about 70 EUR per unit (2 temperature sensors per unit – out/in). However, taking into account that usually new technologies becoming more affordable after some time, authors foresee that application of LoRa sensors will be also economically feasible in the future.

Conclusions

LoRa sensors can be used for bee colony data collection for realisation of Precision Beekeeping. Advantage of LoRaWAN technology is data transmission range, which is crucial when Wi-Fi network is not available. LoRaWAN network solutions could be applicable in regions, where mobile networks have poor coverage and quality of services (e.g., Internet), for example African region, where is a good potential for Precision Beekeeping, but new technologies are not implemented so quickly.

Still Precision Beekeeping is not only limited by the temperature measurements; next important parameter is weight of the colony. Equipping scales with LoRa technology would be a good solution, because in that case amount of LoRa radio chip price will be comparable with scales price.

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References

Augustin A., Yi J., Clausen T., Townsley W.M. (2016). A study of LoRa: Long range & low power networks for the Internet of Things. Sensors, 16(9), 1466.
Georgiou O., Raza U. (2017). Low power wide area network analysis: Can LoRa scale? IEEE Wireless Communications Letters, 6(2), pp.162–165.
Kviesis A., Zacepins, A. (2015). System architectures for real-time bee colony temperature monitoring. Procedia Computer Science, 43, pp.86–94.
Li S., Xu L., Zhao S. (2015). The internet of things: a survey. Information Systems Frontiers, 17(2), pp.243–259.
Meikle W.G., Holst N. (2014). Application of continuous monitoring of honeybee colonies. Apidologie, 46(1), pp.10–22.
Petajajarvi J., Mikhaylov K., Roivainen A., Hanninen T., Pettissalo M. (2015). On the coverage of LPWANs: Range evaluation and channel attenuation model for LoRa technology. 14th International Conference on ITS Telecommunications, ITST 2015. pp. 55–59.
Raza U., Kulkarni P. Sooriyabandara M. (2016). Low power wide area networks: A survey. arXiv preprint arXiv:1606.07360.
Seye M.R., Gueye B., Diallo M. (2017). An evaluation of LoRa coverage in Dakar Peninsula. Information Technology, Electronics and Mobile Communication Conference (IEMCON). pp. 478–482.
Stalidzans E., Berzonis A. (2013). Temperature changes above the upper hive body reveal the annual development periods of honey bee colonies. Computers and Electronics in Agriculture, 90, pp.1–6.
Terry B. (2006). Precision Agriculture, Thomson Delmar learning.
Xue-fen W., Xing-jing D., Yi Y., Jing-wen Z., Sardar M.S., Jian C. (2017). Smartphone based LoRa in-soil propagation measurement for wireless underground sensor networks. In 2017 IEEE Conference on Antenna Measurements & Applications (CAMA). IEEE, pp. 114–117.
Zacepins A., Brusbardis V., Meitalovs J., Stalidzans E. (2015). Challenges in the development of Precision Beekeeping. Biosystems Engineering, 130, pp.60–71.
Zhao W., Lin S., Han J., Xu R., Hou L. (2017). Design and Implementation of Smart Irrigation System Based on LoRa. In 2017 IEEE Globecom Workshops (GC Wkshps). IEEE, pp. 1–6.

2.3 February, 2019 – Bee World – Challenges for Beekeeping in Indonesia with Autochthonous and Introduced Bees

Authors: Kristina Gratzer, Fajar Susilo, Dwi Purnomo, Sascha Fiedler & Robert Brodschneider

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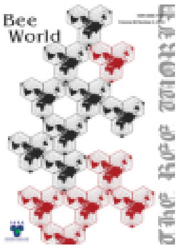

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Challenges for Beekeeping in Indonesia with Autochthonous and Introduced Bees

Kristina Gratzer, Fajar Susilo, Dwi Purnomo, Sascha Fiedler and Robert Brodschneider

The current beekeeping situation in Indonesia

Indonesia has a surface area of 1.91 Mkm² and with its more than 18,000 islands and ~113 Mha (2010) of forest area, the country harbors flora and fauna rich in diversity (Abood, Lee, Burivalova, Garcia-Ulloa, & Koh, 2015; Cribb & Ford, 2009; Hansen et al., 2013; United Nations, 2018). The remarkable diversity is also reflected by the number of bee species. Thus, 8 out of 9 species of the genus *Apis*, with *Apis laboriosa* as the only absent one, as well as more than 40 stingless bee species were observed in Indonesia (Gupta, Reybroeck, van Veen, & Gupta, 2014; Hadisoesilo, 2001; Hadisoesilo et al., 2008; Kahono, Chantawannakul, & Engel, 2018; Koeniger, Koeniger, & Tingek, 2010; Rasmussen, 2008; Roubik, 2005; Tanaka, Roubik, Kato, Liew, & Gunsalam, 2001; Theisen-Jones & Bienefeld, 2016).

It has been estimated that 66% of the world's crop species are pollinated by bees, including honey bees, bumble bees and solitary bees (Kremen, Williams, & Thorp, 2002; Partap, 2011). Beekeeping not only positively contributes to income gain, it also plays a role in increased food security, but beekeeping activity and its potential receives only subordinate attention within the Indonesian government and population. According to scientists from the Universitas Padjadjaran (UNPAD, Bandung, Indonesia), bee businesses are mostly considered as a part time farming activity and not only parts of the local community, but people from every social class are not aware of the bees' benefits (Chantawannakul, Williams, & Neumann, 2018). As found in a survey by UNPAD and CV. Primary Indonesia (Labtek Indie), among 80 citizens 57.5% had certain prejudices against bees. Those range from insufficient profitability, to fear of bee stings, to a lack of knowledge on the importance of bees as pollinators. Furthermore, there are field owners fearing bees have a negative impact on their crops' productivity. They do not want bees or beehives near their property and in a consequence some of them are willing to burn those colonies, if verbal warnings were ignored by the beekeepers. Indonesia is the 4th most populous country worldwide with a population that reached 264 million in 2018 (FAOSTAT, 2018). The population growth is accompanied by a significant stress for the Indonesian ecosystem and a continuous increase of used land area, triggered by rising demands of natural resources like timber and food (Abood et al., 2015). To antagonize the existing trend, beekeeping can be used to sensibilize the population towards the importance of forest conservation and non-timber materials.

So far, local beekeepers use mostly native honey bee species like *Apis cerana* or Meliponini colonies for managed beekeeping (Figure 2) (Schouten, Lloyd, & Lloyd, 2019), but it is also common to practice the art of honey hunting from wild living, so far not-manageable, *Apis dorsata* colonies (Crane, Van Luyen, Mulder, & Ta, 1993; Gupta et al., 2014). Besides honey hunting and beekeeping, Bradbear and FAO (2009) defined a third type of apicultural activity: "Bee maintaining"; an intermediary stage of beekeeping, where humans safeguard wild living colonies. The colonies are not kept in hives, but honey collectors often provide artificial nesting places, for example traditional *tikung, tingku* or also called *sunggau* (wooden honey boards or tree trunks) (Hadisoesilo, 2002). A similar method to maintain *A. dorsata* colonies, observed in Indonesia and elsewhere in South-East Asia, is the use of special rafters (Bradbear & FAO, 2009; Crane et al., 1993). *Tikungs* are trapezium shaped boards often made from banyan (*Ficus benghalensis*) wood, which are placed between tree branches to attract feral *A. dorsata* colonies. If the *tikung* is occupied, the bees build their nest on it while they forage on the same and on neighboring trees in flower. Harvesting takes place during the rainy season and honey collectors cut only the top of the honey containing part of the comb to protect the brood and to maintain the colony. To obtain the honey and separate it from beeswax, it is not common to squeeze, but gently let the honey flow through filter fabric (WWF, 2010) (Figure 1). Once a *tikung* is occupied by a swarm, it is believed, that the same colony remigrates to it every year (Paar, Oldroyd, Huettinger, & Kastberger, 2004). This method may be a good alternative to the less secure and more common practice of honey hunting and is also used in other Asian countries (de Jong, 2000; Mahindre, 2000).

To demonstrate the potential of wild honey production with *tikungs*, the Sentarum Lake Beekeeper Association (APDS), consisting of 217 beekeepers, recorded wild honey harvests. This was 4.3 t in 2007 and even reached 16.5 t in 2008 to 2009. The total potential honey production for this area is estimated to reach 30 t per year (WWF, 2010).

There are only cryptic amounts of literature available on apiculture in Indonesia. Within the European Union's Horizon 2020 project SAMS ("Smart Apiculture

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Figure 1. Harvesting of wild honey in Semanggit Village, Selimbau District, Kapuas Hulu Regency, West Kalimantan, Indonesia. (a) Honey collector climbs the tree to reach the prior installed tikung; (b) only the top of the honeycomb is harvested; (c) smoke producing tool for calming feral bees; (d) filtering process of harvested honey. Photos by Yohanes Kurnia Irawan, used with permission.

Management Systems"), a review of literature was conducted, and information was summarized in a growing Wikipedia-like database (https://wiki.sams-project.eu). For example, no official key numbers representing colony numbers for the whole country are available, but only limited datasets: e.g. in West Java, 7,141 *Apis mellifera* hives were managed and 35.8 t of honey were produced in this area in 2016 (UNPAD, personal communication). Unfortunately, there are no hive numbers for the more commonly kept *A. cerana* bees.

Conforming to data on honey import and export available from FAOSTAT (2018), Indonesia can be regarded as a net importer of honey (mostly from Asia). In detail, honey export in 2013 reached 207 t and 2.35 million USD, while 2,177 t of honey (8.33 million USD) were imported within the same year (FAOSTAT, 2018). According to UNPAD, in 2018 high quality honey offered on the domestic market was sold for a prize of 200,000 Rupiahs (~14 USD). Nevertheless, the majority of the sold honey is considered from lower quality, containing often more than 25% of moisture and the alteration with sugar syrup is also a common problem (White, Platt, Allen-Wardell, & Allen-Wardell, 1988). The honey bee product yield is low due to a lack of beekeeping know-how and other factors like the absconding behavior of native bees, bee forage availability, and the indiscriminate use of pesticides (Amir & Pengembangan, 2002; Oldroyd & Nanork, 2009).

Little information is given on commonly applied treatments against honey bee pests and pathogens and no national honey bee health program exists. Besides the knowledge on the presence of parasitic mites (Anderson, 1994; Diao et al., 2018; Rosenkranz, Aumeier, & Ziegelmann, 2010), information on the national distribution of organisms affecting honey bee health is completely missing (Ellis & Munn, 2005).

Western honey bee vs. Eastern honey bee

There is no agreement on the exact introduction date of *A. mellifera* to Indonesia. Either way, there is evidence of several unsuccessful trials of bringing the Western honey bee into the country, before it was successfully introduced in Java in the second half of the 20th century, probably in 1967 or 1972 (Engel, 2012; Hadisoesilo, Shanti & Kuntadi, 2002). As a consequence, *A. mellifera* spread all over the island, and until today the majority of *A. mellifera* apiaries are still found in this area (Kahono et al., 2018). Morphological and genetic studies are needed to identify the origin(s) of the introduced *A. mellifera* subspecies. Numerous beekeepers all over Asia believing in the advantages of *A. mellifera* are willing to give up beekeeping with *A. cerana*. A survey by Theisen-Jones and Bienefeld (2016) revealed that in Indonesia the remaining percentage of managed *A. cerana* lays between 45% and 60% (compared to introduced *A. mellifera*), while native species getting more and more replaced by the introduced *A. mellifera* all over Asia (e.g., in Thailand beekeeping with *A. cerana* decreased by 95%). Due to the archipelagos structure of Indonesia, those numbers may vary strongly between regions and islands.

Both mentioned *Apis* species do have their advantages for managed beekeeping. The colony size of *A. cerana* ranges from 2,000 to 20,000, while *A. mellifera* colonies reach between 30,000 and 50,000, latter have higher productivity and therefore the harvesting of honey bee products is more profitable (Crane, 1990). The higher productivity of *A. mellifera* is based on its survival strategy to hoard as much honey as possible to ensure the survival of the colony in times of food shortage (winters, droughts, excessive rainfalls) (Crane, 1984). *A. cerana* follows a different strategy by having a high tendency to abscond in periods of unfavorable environmental conditions (triggered by tropical climate, pressure of pathogens/pests/predators, or insufficient forage-opportunities). Consequently, *A. cerana* does not store large amounts of honey (Koetz, 2013). Differences in the foraging behavior between the two *Apis* species are also observable, with *A. mellifera* having a wider foraging range, than *A. cerana* (Couvillon & Ratnieks, 2015; Koetz, 2013). Nevertheless, the Eastern honey bee is an excellent pollinator.

Apis mellifera and *Apis cerana* drones are attracted by similar pheromones secreted by the particular queen. Mating between species is possible, but hybridization blocks, such as morphological differences in reproductive organs, may result in reproductive failure (Ruttner & Maul, 1983). Considering the lower colony size of *A. cerana*, they are more affected by interspecific mating and are less capable of complementing high drone losses (Moritz, Härtel, & Neumann, 2005). Due to the higher aggressiveness of *A. mellifera*, they are often more successful in robbing honey from other honey bee species and subspecies than *vice versa*, which could lead to damage of autochthonous colonies (Chantawannakul, Petersen, & Wongsiri, 2004; Oldroyd & Nanork, 2009).

The question is, regarding the consequences of the long-term costs of replacing *A. cerana* colonies, is *A. mellifera* really the better alternative for future beekeeping in Indonesia? Oldroyd and Nanork (2009) do not believe in a severe impact of *A. mellifera* on *A. cerana*

Figure 2. (a) and (b) *Apis cerana* housing hives on stands, a technique to reduce the risk of predation (ants, lizards, foxes, etc.); (c) a frame including *Apis cerana* brood, honey and pollen; (d) sun melting pot to separate wax from honey and to reduce honey's water content; (e) and (f) managed beekeeping with stingless bees (*Trigona* sp.). Locations for Figures (a), (c), (e), (f) at Gunung Arca Apiary Center, Sukabumi, West Java, Indonesia. Locations for figures (b) and (d) were situated in Bandung, West Java, Indonesia. Photos by Sascha Fiedler.

colonies, because feral *A. mellifera* colonies in Asia, which would also include Indonesia, are so far unknown. This fact may have different reasons: the climate of the tropics brings only minor variation in day length and thus, Western honey bees cannot further adapt on these conditions (e.g., brood production). In comparison, feral *A. mellifera* may be only a question of time, if there are efforts to introduce African *A. mellifera* subspecies that are adapted to tropical climate (Moritz et al., 2005).

In Indonesia, *A. mellifera* is mostly put in context with migratory beekeeping, but this practice is not widely used and underdeveloped (UNPAD, pers. communication). Widiarti and Kuntadi (2012) conducted an interview-based study in Central Java and identified the major constraints of developing migratory beekeeping with *A. mellifera* resulting in a shortage of bee forage, capital, extension, technical training and workshops, as well as breeding and honey bee health issues (pests, pathogens). Besides, existing prejudices among the Indonesian population may also be an important contributing factor to the unpopularity of this beekeeping practice.

One special phenomenon, negatively affecting the bee forage availability, was described by the Ministry of Agriculture in 2011: a change in market trend from traditional kapok to modern mattresses led to a significant decrease of the kapok tree population, namely 44% from 2000 to 2009. Kuntadi (2008) further revealed a 10.2% decline of kapok trees in the migratory beekeeping region East Java Province. Kapok trees serve as important forage plant for bee species and especially for beekeepers using *A. mellifera* for migratory beekeeping the plant is valuable.

Performing migratory beekeeping in Indonesia is not easy and financial costs are high. The biggest expenses in managing *A. mellifera* are transportation and the purchase of sugar. One colony needs at least 1 kg of sugar per month during the drought season, which may occur up to 5 months (December to April). In Java, beekeepers use a similar migratory route (from West and East, to Central Java) and therefore the competition for the best forage sites is high. Those differ in food availability and therefore bee colonies often need supplemental feeding and cause financial penalties. In a consequence, some beekeepers who fail to reach their production target sell their hives after the season. To promote the development of migratory beekeeping in Indonesia, it is suggested to increase the availability of natural bee forage, and to establish governmental regulations for colony migration and logging policies.

Krongdang, Evans, Chen, Mookhploy, and Chantawannakul (2018) compared the susceptibility of *A. mellifera* and *A. cerana* against *Paenibacillus larvae*, the causative agent of American Foulbrood, and found a higher immune response, reflected by increased gene expression levels of antimicrobial peptides (AMPs), in the Eastern honey bee. Honey bees produce AMPs in response to pathogens and parasites and therefore the monitoring of AMP gene expression acts as a suitable tool for studying innate immunity. In general, *A. cerana* has a higher disease-resistance, particularly against parasitic mites, but seems to be more sensitive to Thai Sac Brood Virus (Theisen-Jones & Bienefeld, 2016). Increased hygienic standards (bees clean themselves and others at higher frequencies, infected brood is removed before sealing the brood cells) positively contribute to the higher resistance and therefore the treatment with acaricides against *Varroa* infestation is not necessary, which results in less needed equipment, knowledge and time effort for the beekeeper (Boecking & Spivak, 1999). *A. cerana* bees have further advantages: they are known to have a gentle temperament, they do not necessarily need supplementation if forage is available year-round, they need less foraging areas, and if well-acclimated, they react less sensitive to changes in climate conditions and are able to forage under

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more unfavorable conditions (Koetz, 2013; Oldroyd & Nanork, 2009; Theisen-Jones & Bienefeld, 2016). In contrast to this, survival of *A. mellifera* is impacted if *Varroa* or *Tropilaelaps* spp. infestations stay untreated. The tropical weather conditions may also lead to decreased foraging behavior of *A. mellifera* and in a consequence to greater demand of supplemental feeding (Theisen-Jones & Bienefeld, 2016).

The shifting from dry to rainy season and the decrease of natural bee forage is a challenge for beekeepers and their bee colonies and demands proper bee management, such as offering the right supplemental food. Kuntadi (2008) compared three different soybean flours (roasted, boiled and fermented with peeled bean) as protein supplement. The results indicated that soybean flour processing influences the protein uptake of honey bees. Specifically, the bees preferred boiled and fermented (with peeled bean) soybean flours over the roasted one. The processing method of the protein supplement did not affect the mortality of bees neither the honey bee colony size.

Preservation issue of autochthonous *Apis* species

As studies on *A. mellifera* in Indonesia are exceptional, information on a possible impact of local climate and flora on *A. mellifera* beekeeping and its profitability is missing. It has to be mentioned, that before the selection of desired traits, *A. mellifera* produced, similar to *A. cerana*, only 2–5 kg honey per colony (Theisen-Jones & Bienefeld, 2016). Hence, it is very likely that selective breeding of *A. cerana* will also result in higher honey yield per colony. This may be a possible compromise that favors beekeeping with, and therefore the preservation of *A. cerana*. Of course, in a country with numerous amounts of feral *A. cerana* colonies, there will always be interactions with their hived sisters and therefore proper breeding programs are not easy to initiate and need adequate governmental, non-governmental and scientific support. Another alternative of preserving autochthonous bee species is focusing on *A. dorsata*. Several projects exist, aiming to encourage the people of Indonesia to harvest honey not from *A. cerana*, but from *A. dorsata* nests, rather than changing to beekeeping with *A. mellifera*. Provided, honey hunting is practiced in a sustainable and hygienic way: only harvest the honeycombs instead of destroying the whole nest, wearing protective clothes, or filtrating the honey through simple closed mashed nets (Oldroyd & Nanork, 2009). Native bee species are known to be more resistant against pests and pathogens, while beekeeping with the Western *A. mellifera* implicates regular hive-inspection and management as well as larger foraging areas to successfully harvest large amounts of honey and other honey bee products and therefore is more time-consuming and requires more knowledge (Chantawannakul et al., 2004; Theisen-Jones & Bienefeld, 2016). Nevertheless, if the beekeepers are proper trained, the higher amount of invested time is relativized with the higher productivity of *A. mellifera* that leads to a significantly higher income of beekeepers.

Conclusions

Strengthening the beekeeping sector in Indonesia leads not only to improved protection of the environment but also to an increased quality of life and income. Better living standards may be achieved by marketing bee products, or by improved yields of agricultural goods. Thus, it is important to spread the word on the importance of bees and beekeeping within the government and the Indonesian population. Besides convincing the citizens, it is also important to train beekeepers and extension workers in business and beekeeping relating topics and to conduct field research on honey bee health, disease recognition, and dissemination of control methods. The knowledge about beekeeping with the indigenous honey bee species *A. cerana* already exists (Schouten et al., 2019), while in Indonesia beekeeping with introduced *A. mellifera* is often limited to the still underdeveloped migratory beekeeping practice. Both bee species have their advantages and in the end, this literature based study gives no ultimate answer on which one should be encouraged for beekeeping in Indonesia, but it has to be mentioned that "poor people should not be expected to bear the burden of conservation, which is the responsibility of us all" (Oldroyd & Nanork, 2009).

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References

Abood, S. A., Lee, J. S. H., Burivalova, Z., Garcia-Ulloa, J., & Koh, L. P. (2015). Relative contributions of the logging, fiber, oil palm, and mining industries to forest loss in Indonesia. *Conservation Letters, 8*(1), 58–67. doi:10.1111/conl.12103

Amir, A., & Pengembangan, Y. U. M. (2002). Forest-dependent community development through *Apis cerana* beekeeping programm. *Apiacata, 4*, 1–4.

Anderson, D. L. (1994). Non-reproduction of *Varroa jacobsoni* in *Apis mellifera* colonies in Papua New Guinea and Indonesia. *Apidologie, 25*(4), 412–421. doi:10.1051/apido:19940408

Boecking, O., & Spivak, M. (1999). Behavioral defenses of honey bees against *Varroa jacobsoni* Oud. *Apidologie, 30*(2–3), 141–158. doi:10.1051/apido:19990205

Bradbear, N., & Food and Agriculture Organization of the United Nations (FAO). (2009). Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting processing and marketing of their products. *FAO, Rome, Non-Wood Forest Products, 19*, 1–194.

Chantawannakul, P., Petersen, S., & Wongsiri, S. (2004). Conservation of honey bee species in South East Asia: *Apis mellifera* or native bees? *Biodiversity, 5*(2), 25–28. doi:10.1080/14888386.2004.9712726

Chantawannakul, P., Williams, G., & Neumann, P. (2018). *Asian beekeeping in the 21st century*. Singapore: Springer.

Couvillon, M. J., & Ratnieks, F. L. W. (2015). Environmental consultancy: Dancing bee bioindicators to evaluate landscape "health". *Frontiers in Ecology and Evolution, 3*(44), 1–8.

Crane, E. (1984). Honeybees. Evolution of domesticated animals. In I.L. Mason (Ed.), *From evolution of domesticated animals* (Vol. 65, pp. 403–415). London: Longman Group.

Crane, E. (1990). *Bees and beekeeping: Science, practice, and world resources*. Ithaca, NY: Comstock Pub. Associates.

Crane, E., van Luyen, V., Mulder, V., & Ta, T. C. (1993). Traditional management system for *Apis dorsata* in submerged forests in Southern Vietnam and Central Kalimantan. *Bee World, 74*(1), 27–40. doi:10.1080/0005772X.1993.11099151

Cribb, R. B. & Ford, M., (2009). Indonesia as an archipelago: Managing islands, managing the Seas. In R. B. Cribb & M. Ford (Eds.), *Indonesia beyond the water's edge: Managing an archipelagic state*. Singapore: ISEAS Publishing (Institute of Southeast Asian Studies).

De Jong, W. (2000). Micro-differences in local resource management: The case of honey in west Kalimantan, Indonesia. A brief comment. *Human Ecology, 28*(4), 631–639. doi:10.1023/A:1026443915926

Diao, Q., Sun, L., Zheng, H., Zeng, Z., Wang, S., Xu, S., … Wu, J. (2018). Genomic and transcriptomic analysis of the Asian honeybee *Apis cerana* provides novel insights into honeybee biology. Scientific Reports, *8*(1), 1–14.

Ellis, J. D., & Munn, P. A. (2005). The worldwide health status of honey bees. *Bee World, 86*(4), 88–101. doi:10.1080/0005772X.2005.11417323

Engel, M. S. (2012). The honey bees of Indonesia (Hymenoptera: Apidae). *Treubia, 39*, 41–49.

FAOSTAT. (2018). *FAOSTAT database collections*. Rome: Food and Agriculture Organization of the United Nations.

Gupta, R. K., Reybroeck, W., van Veen, J. W., & Gupta, A. (2014). *Beekeeping for poverty alleviation and livelihood security: Vol. 1: Technological aspects of beekeeping*. Dordrecht: Springer.

REVIEW ARTICLE

Hadisoesilo, S. (2001). *Diversity in traditional techniques for enticing Apis dorsata colonies in Indonesia*. Paper presented at the Proceedings of the 37th International congress, Apimondia, Durban.

Hadisoesilo, S. (2002). Tingku–A traditional management technique. *Bees for Development Journal, 64*, 4–5.

Hadisoesilo, S., Raffiudin, R., Susanti, W., Atmowidi, T., Hepburn, C., Radloff, S. E., … Hepburn, H. R. (2008). Morphometric analysis and biogeography of *Apis koschevnikovi* Enderlein (1906). *Apidologie, 39*(5), 495–503. doi:10.1051/apido:2008029

Hadisoesilo, S., Shanti, E. N., & Kuntadi, T. H. (2002). Drone flight times of *Apis cerana* and *Apis mellifera* in the Island of Java. *Apicata, 1*, 1–3.

Hansen, M. C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., …, Townshend, J. R. G. (2013). Hansen/UMD/Google/USGS/NASA Tree Cover Loss and Gain Area. University of Maryland, Google, USGS, and NASA. Retrieved from www.globalforestwatch.org

Kahono, S., Chantawannakul, P., & Engel, M. S. (2018). Social bees and the current status of beekeeping in Indonesia. In P. Chantawannakul, G. Williams & P. Neumann (Eds.), *Book: Asian beekeeping in the 21st century* (pp. 287–306). Singapore: Springer.

Koeniger, N., Koeniger, G., Tingek, S. (2010). *Honey bees of Borneo: Exploring the centre of Apis diversity*. Borneo: Natural History Publication Malaysia.

Koetz, A. H. (2013). Ecology, behaviour and control of *Apis cerana* with a focus on relevance to the Australian incursion. *Insects, 4*, 558–592. doi:10.3390/insects4040558

Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences of the United States of America, 99*(26), 16812–16816. doi:10.1073/pnas.262413599

Krongdang, S., Evans, J. D., Chen, Y., Mookhploy, W., & Chantawannakul, P. (2018). Comparative susceptibility and immune responses of Asian and European honey bees to the American foulbrood pathogen, *Paenibacillus larvae*. Insect Science. doi:10.1111/1744-7917.12593.

Kuntadi. (2008). Perkembangan Koloni *Apis Mellifera* L. Yang Diberi Tiga Formula Kedelai Sebagai Pakan Buatan Pengganti Serbuk Sari [Colony Development of *Apis mellifera* L. Fed on Three Formulas of Soybean as Artificial Foods to Substitute Pollen]. *Jurnal Penelitian Hutan dan Konservasi Alam, 5*(4), 367–379. doi:10.20886/jphka.2008.5.4.367-379

Mahindre, D. B. (2000). Developments in the management of *Apis dorsata* colonies. *Bee World, 81*(4), 155–163. doi:10.1080/0005772X.2000.11099489

Moritz, R. F. A., Härtel, S., & Neumann, P. (2005). Global invasions of the western honey bee (*Apis mellifera*) and the consequences for biodiversity. *Écoscience, 12*(3), 289–301. doi:10.2980/i1195-6860-12-3-289.1

Oldroyd, B. P., & Nanork, P. (2009). Conservation of Asian honey bees. *Apidologie 40* (3), 296–312. doi:10.1051/apido/2009021

Paar, J., Oldroyd, B. P., Huettinger, E., & Kastberger, G. (2004). Genetic structure of an *Apis dorsata* population: The significance of migration and colony aggregation. *Journal of Heredity, 95*(2), 119–126. doi:10.1093/jhered/esh026

Partap, U. (2011). The pollination role of honey bees. In H. R. Hepburn & S. E. Radloff, (Eds.), *Honey bees of Asia* (pp. 227–255). Berlin: Springer.

Rasmussen, C. (2008). *Catalog of the Indo-Malayan/Australasian stingless bees (Hymenoptera: Apidae: Meliponini)* (*Zootaxa* 1935). Auckland: Magnolia Press.

Rosenkranz, P., Aumeier, P., & Ziegelmann, B. (2010). Biology and control of *Varroa destructor*. *Journal of Invertebrate Pathology, 103*, 96–119.

Roubik, D. W. (2005). Honey bees in Borneo. In D. W. Roubik, S. Sakai, & A. A. Hamid Karim (Hrsg.), *Pollination ecology and the rain forest* (Bd. 174, 89–103). New York, NY: Springer.

Ruttner, F., & Maul, V. (1983). Experimental analysis of reproductive interspecies isolation of *Apis mellifera* L. and *Apis cerana* Fabr. *Apidologie, 14*(4), 309–327. doi:10.1051/apido:19830405

Schouten, C. N., Lloyd, D. J., & Lloyd H. (2019). Beekeeping with the Asian Honey Bee (*Apis cerana javana* Fabr) in the Indonesian Islands of Java, Bali, Nusa Penida and Sumbawa. *Beeworld, 96*(2). doi:10.1080/0005772X.2018.1564497.

Tanaka, H., Roubik, D. W., Kato, M., Liew, F., & Gunsalam, G. (2001). Phylogenetic position of *Apis nuluensis* of northern Borneo and phylogeography of *A. cerana* as inferred from mitochondrial DNA sequences. *Insectes Sociaux, 48*(1), 44–51. doi:10.1007/PL00001744

Theisen-Jones, H., & Bienefeld, K. (2016). The Asian honey bee (*Apis cerana*) is significantly in decline. *Bee World, 93*(4), 90–97. doi:10.1080/0005772X.2017.1284973

United Nations. (2018). *UNSTATS database collections*. New York, NY: United Nations Statistic Division.

White, J. W., Platt, Jr. J. L., Allen-Wardell, G., & Allen-Wardell, C. (1988). Quality control for honey enterprises in less-developed areas: An Indonesian example. *Bee World, 69*(2), 49–62. doi:10.1080/0005772X.1988.11098951

WWF. (2010). Madu Danau Sentarum: produk organik berbasis pengetahuan lokal [Sentarum Lake's Honey: organic products based on local wisdom]. Retrieved from https://www.wwf.or.id/?21121/Madu

Widiarti, A., & Kuntadi, K. (2012). Budidaya Lebah Madu *Apis mellifera* L. Oleh Masyarakat Pedesaan Kabupaten Pati, Jawa Tengah [Beekeeping of Apis mellifera L. Honeybees by Rural People in Pati Regency, Central Jawa]. *Jurnal Penelitian Hutan dan Konservasi Alam, 9*(4), 351–361. doi:10.20886/jphka.2012.9.4.351-361

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2.4 March 2019, SAMS – Internationale Partnerschaft für intelligente Dienstleistungen in der Bienenhaltung

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Beiträge des ÖEG-Kolloquiums in Graz, 16.03.2019: Kurzfassungen der Vorträge und Poster

SAMS - Internationale Partnerschaft für intelligente Dienstleistungen in der Bienenhaltung

Kristina Gratzer & Robert Brodschneider

Bienengesundheit und nachhaltige Bienenhaltung sind Schlüsselfaktoren für eine erfolgreiche Landwirtschaft. Sinkende Bestäubungsleistung und Honigproduktion durch eine Verschlechterung der Bedingungen für Honigbienen gefährden nicht nur den Lebensunterhalt der Imker und Imkerinnen, sondern auch die weltweite landwirtschaftliche Produktion und betrifft somit die Ernährung der Weltbevölkerung.

SAMS (International Partnership on Innovation in Smart Apiculture Management Services) ist ein von der Europäischen Union gefördertes Projekt innerhalb des Großprojektes Horizon 2020-ICT-39-2016-2017 und fördert die internationale Kooperation zwischen der EU und Entwicklungsländern hinsichtlich der Themen nachhaltige Landwirtschaft und ICT-Lösungen (Information and Communication Technologies). In vielen Entwicklungsländern spielt die Agrarwirtschaft eine besonders große Rolle, darum nutzt SAMS das Potential von Bienen und Bienenwirtschaft für die Entwicklungshilfe. Das SAMS-Konsortium besteht aus vier europäischen Partnern (Österreich, Lettland, zwei aus Deutschland), sowie Partnern aus Äthiopien und Indonesien. Das Projekt folgt dem Entwicklungsziel: “End hunger, achieve food security, improve nutrition and promote sustainable agriculture”.

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ÖEG-Kolloquium 2019 Entomologica Austriaca 26: 115–133

Äthiopien und Indonesien zeichnen sich jeweils durch ein diverses Ökosystem aus, das zahlreiche Bienenvölker unterschiedlicher Spezies und Subspezies beheimatet. In Äthiopien hat die Bienenhaltung bereits eine lange Tradition und auch in Indonesien spielen die traditionelle Imkerei, sowie verwandte Aktivitäten wie das Honigsammeln von wild lebenden Bienenvölkern ("honey hunting") eine Rolle. Trotz der Voraussetzungen und des Vorhandenseins eines wirtschaftlichen Bienen-Sektors, ist das Potential an Honigproduktion und Vermarktung noch lange nicht ausgeschöpft. Hier setzt SAMS an und verfolgt das Ziel zu unterstützen und weiterzuentwickeln. SAMS liefert eine technisch versierte ICT-Lösung für die Bienenhaltung und ist gekennzeichnet durch folgende Eigenschaften: a.) günstige und einfach zu bedienende Open-Source-ICT-Anwendung für den Bienenstock (Open Source Sensor, Informations-Verteilungssystem, unabhängige Energieversorgung), der lokal produziert und an lokale Bedingungen adaptiert werden kann. Dies ist essentiell, da die in Äthiopien autochthon vorkommenden Völker der Honigbiene (*Apis mellifera*) andere Ansprüche an ihre Umgebung haben, als jene, die ursprünglich in Indonesien beheimatet sind (*A. cerana*), oder auch dort eingeführt wurden (*A. mellifera*); b.) Entscheidungshilfe für ImkerInnen. Dabei werden die Sensor-gestützten Datenausgaben mit anderen Informationsquellen und Vorhersagemodellen kombiniert, um so Rückschlüsse auf den Status der Bienenkolonie (Gesundheit, Vitalität, Produktivität, etc.) zu liefern und ImkerInnen zu alarmieren, sobald das System Abweichungen vom Normalzustand registriert; c.) Erstellung von Geschäftskonzepten für die Zusammenarbeit mit Akteuren, die innerhalb der Wertschöpfungskette für Bienenprodukte agieren. SAMS versteht sich als Werkzeug für die Präzisions-Bienenhaltung, die dazu beiträgt durch technisch unterstütztes Monitoring von Bienenvölkern den Ressourcenverbrauch zu minimieren und die Produktivität zu maximieren. Lokale Klein-Imkereien bieten perfekte Rahmenbedingungen, um das Potential der Anwendung in Entwicklungsländern zu demonstrieren und diese vor Ort zu verbreiten. Dabei stellt SAMS die Bedürfnisse der Endnutzer in den Fokus und ermöglicht aktives Monitoring, sowie Fernüberwachung der Bienenvölker. SAMS verbessert die Produktion von Bienenprodukten, kreiert Jobs (insbesondere für Jugendliche/Frauen), triggert Investments und schafft den Wissensaustausch zwischen verschiedenen Netzwerken. Um noch mehr über SAMS herauszufinden, besuchen Sie unsere Projekt-Webseite: https://sams-project.eu/. Um mehr über die Bienen und Imkerei in Äthiopien und Indonesien zu erfahren, besuchen Sie den im Rahmen des Projektes erstellten Wiki: https://wiki.sams-project.eu.

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Abstract of SAMS - International partnership for intelligent services in beekeeping

UNIGRA presented the SAMS poster at the "ÖEG Tagung" in March 2019. Additionally, we wrote a short summary of the SAMS project and its overall aims, like the development of a bee monitoring system. Further we mentioned the different bee species used for beekeeping in Ethiopia and in Indonesia and the advantages for beekeepers using such a monitoring system for their bee colonies. The text was published in Entomoligica Austriaca.

2.5 May, 2019 – Biosystems Engineering book of abstracts – International Partnership on Innovation in Smart Apiculture Management Services

Authors: Zacepins A., Komasilovs V. & Kviesis A.

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BSE 10th International Conference
Biosystems Engineering
May 8-10, 2019 in Tartu, Estonia

Modular sensory hardware and data processing solution for implementation of the precision beekeeping

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Abstract. For successful implementation of the Precision Apiculture (Precision Beekeeping) approach, immense amount of bee colony data collection and processing using various hardware and software solutions is needed. This paper presents standalone wireless hardware system for bee colony main parameters monitoring (temperature, weight and sound). Monitoring system is based on Raspberry Pi 3 computer with connected sensors. Power supply is granted by the solar panel for reliable operation in places without constant source for power. For convenient data management cloud based data warehouse (DW) is proposed and developed for ease data storage and analysis. Proposed data warehouse is scalable and extendable and can be used for variety of other ready hardware solutions, using variety of data-in/data-out interfaces. The core of the data warehouse is designed to provide data processing flexibility and versatility, whereas data flow within the core is organized between data vaults in a controllable and reliable way. Our paper presents an approach for linking together hardware for bee colony real-time monitoring with cloud software for data processing and visualisation. Integrating specific algorithms and models to the system will help the beekeepers to remotely identify different states of their colonies, like swarming, brood rearing, death of the colony etc. and inform the beekeepers to make appropriate decisions/actions. This research work is carried out within the SAMS project, which is funded by the European Union within the H2020-ICT-39-2016-2017 call. To find out more visit the project website https://sams-project.eu/.

Keywords: Precision beekeeping, data warehouse, bee colony monitoring.

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May 8-10, 2019 in Tartu, Estonia

SAMS - International Partnership on Innovation in Smart Apiculture Management Services

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Abstract. Bee health and sustainable beekeeping are a key for sustainable agriculture worldwide. Risks of depleting honey production threatens livelihoods of beekeepers, but degradation of pollination power of suffering bee colonies threats overall agricultural production and affects entire population. SAMS is a project funded by the European Union within the H2020-ICT-39-2016-2017 call. SAMS enhances international cooperation of ICT (Information and Communication Technologies) and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". The project consortium comprises four partners from Europe (two from Germany, Austria and Latvia) and two partners each from Ethiopia and Indonesia. Beekeeping with small-scale operations provides perfect innovation labs for demonstration and dissemination of cheap and easy-to-use open source ICT applications in developing countries. SAMS proposes implementation of Precision Beekeeping by allowing active monitoring and remote sensing of bee colonies and beekeeping by developing appropriate ICT solutions supporting management of bee health and bee productivity and a role model for effective international cooperation. Precision Beekeeping (Precision Apiculture) is an apiary management strategy based on the monitoring of individual bee colonies to minimize resource consumption and maximize the productivity of bees. Precision Agriculture methods and techniques can be adapted for beekeeping improving the beekeepers knowledge about behaviour of individual bee colonies and prioritize different activities. SAMS addresses requirements of end-user communities on beekeeping in developing countries. It includes technological improvements and adaptation as well as innovative services creation in apiculture based on advanced ICT and remote sensing technologies. SAMS increases production of bee products, creates jobs (particularly youths/women), triggers investments, and establishes knowledge exchange through networks. The final outcome of the project will be a technologically enhanced beehive system and service including the following main components: a) A physical low-cost beehive model, that is locally produced and adapted to local conditions, including integrated open source sensor and information transition technology, as well as energy-supply solution; b) A decision support system that combines the sensor-based data-outputs with other information sources and predictive models to measure, analyse and describe different states of the bee colony such as health, vitality, production, etc.; c) An automatic advisory support tool, which will alert the beekeeper in an easily understandable way if any aberrations from normal states are metered and will provide advice on appropriate countermeasures. The response unit will support the user to avoid losses and to increase the profitability and stability of beekeeping; d) A bee management business concept for the local production and up-scaled implementation of the developed beehives with integrated beehive monitoring system. To find out more visit our project website https://sams-project.eu/.

Key words: precision Beekeeping, smart beehive, bee colony monitoring.

2.6 May, 2019 – Modular sensory hardware and data processing solution for implementation of the precision beekeeping

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Modular sensory hardware and data processing solution for implementation of the precision beekeeping

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Abstract. For successful implementation of the Precision Apiculture (Precision Beekeeping) approach, immense amount of bee colony data collection and processing using various hardware and software solutions is needed. This paper presents standalone wireless hardware system for bee colony main parameters monitoring (temperature, weight and sound). Monitoring system is based on Raspberry Pi 3 computer with connected sensors. Power supply is granted by the solar panel for reliable operation in places without constant source for power. For convenient data management cloud based data warehouse (DW) is proposed and developed for ease data storage and analysis. Proposed data warehouse is scalable and extendable and can be used for variety of other ready hardware solutions, using variety of data-in/data-out interfaces. The core of the data warehouse is designed to provide data processing flexibility and versatility, whereas data flow within the core is organized between data vaults in a controllable and reliable way. Our paper presents an approach for linking together hardware for bee colony real-time monitoring with cloud software for data processing and visualisation. Integrating specific algorithms and models to the system will help the beekeepers to remotely identify different states of their colonies, like swarming, brood rearing, death of the colony etc. and inform the beekeepers to make appropriate decisions/actions. This research work is carried out within the SAMS project, which is funded by the European Union within the H2020-ICT-39-2016-2017 call. To find out more visit the project website https://sams-project.eu/.

Key words: Precision beekeeping, data warehouse, bee colony monitoring.

INTRODUCTION

Bee health and sustainable beekeeping are a key for sustainable agriculture worldwide (Gallai et al., 2009; Kaplan, 2008). Risks of depleting honey production threatens livelihoods of beekeepers, but degradation of pollination power of suffering bee colonies threats overall agricultural production and affects entire population. Approximately 75% of the crops, used for human feeding depends on pollination (Ollerton et al., 2011; Potts et al., 2016). The European honeybee *Apis mellifera* is the most economically valuable pollinator of agricultural crops worldwide. These insects can provide pollination generally to any fruit and vegetable, playing a crucial ecosystem service for agricultural food production and for wild plant diversity and conservation

(Bommarco et al., 2013; Klein et al., 2006). Many national and international projects like ITAPIC[1], Swarmonitor[2], Smartbees[3], PoshBee[4] and others were implemented or are ongoing to study factors and parameters that may contribute to the bee health. In addition, several monitoring sensors have been developed for automatic beehive monitoring thus facilitating the development of the Precision Beekeeping (Meikle & Holst 2015). Precision Beekeeping is defined as an apiary management strategy based on the monitoring of individual bee colonies to minimise resource consumption and maximise the productivity of bees (Zacepins et al., 2015). Nevertheless, there still is a lack of a system which can be widely used and is very affordable for the end users (beekeepers).

Despite the fact there are number of implemented solutions for data collection about bee colonies, only few of them offer basic functionality for data analysis and decision making. This paper describes authors' developed bee colony hardware system for temperature, humidity, weight and sound monitoring linked together with a cloud data warehouse, specially designed for on-line data storage and close to real-time analysis and decision support actions. The proposed approach integrates two stages of the three-phase cycle of the Precision Beekeeping, including data collection and data analysis. Third phase – application of control actions, remains responsibility of the beekeeper. This phase, called also data utilization, usually involves the adjustment of important parameters and making the needed actions (Pentjuss et al., 2011). Author's approach can be integrated into a beekeeping practice to help the bees and pollination service they provide.

Research idea brings clear economic impact for the beekeepers. Proposed solution helps to remotely monitor bee colonies, recognize various states (for example normal, swarming, colony death) and minimise the necessity for on-site colony visits, therefore reducing beekeeper's spending on unneeded travelling to remote apiary. As well, bee colony health can be increased by minimising the number of beehive openings (see Fig. 1) (Stalidzans et al., 2017).

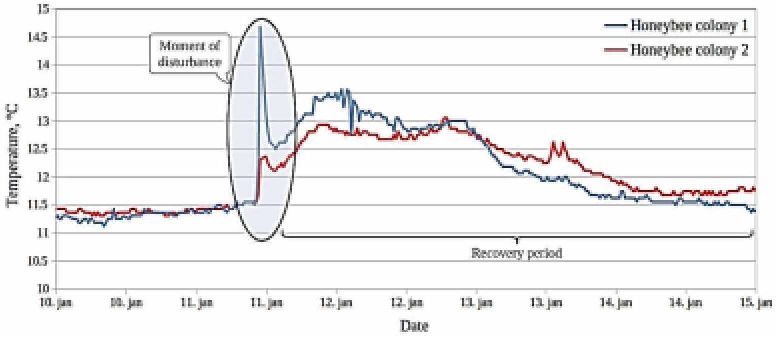

Figure 1. Temperature changes in the bee colony during manual hive weighing.

1 Application of Information Technologies in Precision Apiculture – http://www.itapic.eu
2 http://www.swarmonitor.com
3 Sustainable management of resilient bee populations – http://www.smartbees-fp7.eu
4 Pan-European assessment, monitoring, and mitigation of stressors on the health of bees – http://www.poshbee.eu

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Every time when hive is opened and bee colony is inspected or any other manipulations with hive are done an additional stress is posed for the colony. Such stress can also be caused by manual weighting procedure.

In overall, developed approach facilitates optimization of operational beekeeping costs and minimises colony losses, increasing the profitability and stability of beekeeping.

This research is done within the SAMS[5] project. SAMS is a project funded by the European Union within the H2020-ICT-39-2016-2017 call. SAMS enhances international cooperation of ICT (Information and Communication Technologies) and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". SAMS proposes implementation of Precision Beekeeping by allowing active monitoring and remote sensing of bee colonies and beekeeping by developing appropriate ICT solutions supporting management of bee health and bee productivity and a role model for effective international cooperation. The outcome of the project will be a technologically enhanced beehive system and service including several components, like decision support system, advisory support tool, bee management business concept.

SENSORY HARDWARE FOR BEE COLONY MONITORING

Many parameters of the bee colony can be monitored by the automated system, but not all of them can provide the beekeeper with valuable information. According to literature review and results of recent researches it is concluded, that system should measure temperature, humidity, weight and acoustic parameters of the colony. Temperature and humidity are the most commonly used metrics in precision beekeeping (Meikle & Holst 2015; Zacepins et al., 2015; Meikle et al., 2017). Hive weight is also a useful metric for monitoring the productivity of a colony with a correlation between honey production and different parameters of meteorological conditions (Fitzgerald et al., 2015; Ruan et al., 2017). In addition, monitoring of acoustics of bee colonies can be used for the prediction of e.g. swarming behaviour (Ferrari et al., 2008; Bencsik et al., 2011).

Developed system's architecture is based on proposed approach by (Kviesis & Zacepins 2015), where measurement node sends data to remote server via mobile network. According to the demands, a Raspberry Pi 3 (RPi) was used as Single-Board-Computer (SBC). The RPi was extended with a RPi-Shield-Audio Card and a microphone. A script addresses the sound card and converts the analog audio signals of the microphone. These signals are further broken down into their frequency components by means of a Fast Fourier Transformation (FFT). Using Wi-Fi and a mobile GSM router, the measured values are uploaded to a cloud server and deleted from the SBC memory. In case, radio transmission is not possible, the data remains on the device memory until a connection is established. Conversely, the SBC can also receive updates from the cloud server. Settings, such as the intervals of the data logger, can be changed by user from any computer with internet availability. In addition to the interval sizes for

5 International partnership on innovation in smart apiculture management services –http://www.sams-project.eu

updates and uploads, variables that can be changed including the recording length of the audio signals and the sampling rate. The source codes will be available as open source on SAMS project website (https://sams-project.eu/).

The sensory hardware (see Fig. 2) is capable to obtain temperature data of the inside and outside temperature as well as weight data of the bee colony. A RPi capable sensor for temperature and a load cell in combination with an A/D converter is used for weight measurements. Additional sensors can be connected optionally.

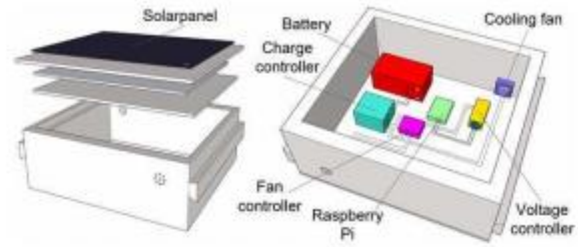

Figure 2. Sensory hardware with casing, solar energy supply, single board computer and cooling.

Sensor placement in a modified broodframe is shown in Fig. 3, and the bee hive with installed monitoring system is demonstrated in Fig. 4.

Figure 3. Sensory placement in a modified broodframe connected with cable.

Figure 4. Bee hive with monitoring system prototype at the test site Witzenhausen of the University of Kassel.

In order to supply the system with electricity, a polycrystalline photovoltaic module with a system voltage of 12 V DC was used as a solar generator. To protect the battery from overcharging, a pulse-width modulated shunt controller with depth discharge protection was selected. To store energy a 12 V lead batteries with a capacity of 18 Ah was built in. For adequate ventilation, a temperature controller was installed in combination with two housing fans.

The energy consumption of the RPi depends on the specific sensor constellation. For the hardware configuration used here, the power consumption was less than 0.5 A. To reduce the consumption, the RPi can simply be started for the relevant measuring intervals using a time-controlled 'power switch'. The component costs for the sensory system run to about 300 euros (see Fig. 5). If several sensor systems are used at one location, the power supply is designed to be shared. This reduces the specific costs

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accordingly. Still it can be seen, that costs for granting power supply with alternative methods (photovoltage system) is already expensive. System costs can be significantly decreased if the system is connected to the electrical grid available at the apiary. A honey chamber of a standard magazine hive for honey bees was selected as the casing for the hardware components. This is familiar to every beekeeper and can easily be placed on a beehive. In addition the construction principle can be transferred to magazine hives of other dimensions easily.

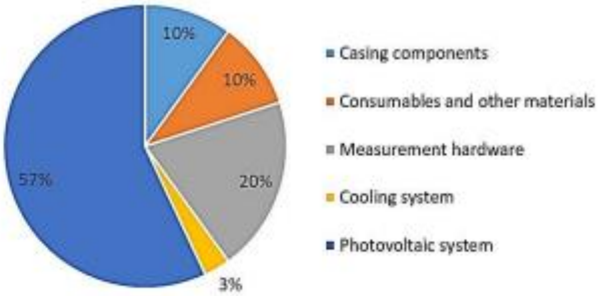

Figure 5. Cost distribution of the monitoring device. Complete system costs are about 300 euros.

DATA WAREHOUSE CONCEPT

Data warehouse (DW) can be considered as a universal system, which is able to operate with different data inputs and have flexible data processing algorithms.

By the definition data warehouse is like an intermediate layer between data provider systems and data consumer systems or end-users (Inmon, 2010). DW provides customizable facilities for data storage management, processing, analysis and output. The DW should be used to help beekeepers run the apiary more effectively by utilising higher amount of available data and accumulated data interpretation knowledge.

Authors suggest implementing DW as a cloud based data storage and processing unit with capabilities to combine different data sources like existing systems and available on-apiary generated data.

Architecture of the developed DW is demonstrated in Fig. 6. DW is capable to analyse data in the real-time or store it for future analysis.

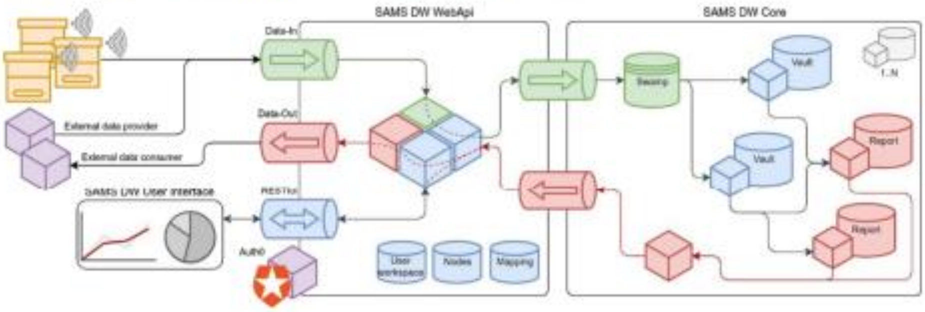

Figure 6. Architecture of the developed data warehouse.

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DW consists of three modules: a) Core – main data storage and processing unit; it receives data about various beekeeping objects in predefined format and distributes it through number of vaults and reports, which apply needed transformation to the data (e.g. aggregation, modelling, decision making); b) WebApi – intermediary unit between 'outer world' and DW Core; it provides number of HTTP interfaces for machine-to-machine interaction with external systems via Internet; main functions of the unit include request authentication and authorization, user private workspace management, data-in and data-out interface configuration and data conversion to/from DW Core supported formats; c) Graphical user interface – single-page web application provides user convenient way for managing the sources of incoming data (e.g. hives with monitoring devices) and getting insights into produced outputs (e.g. reports).

DW Data-in interface provides data input functionality for various data sources – it can be in a form of data files uploaded manually via user interface or via automated (scheduled) scripts, a bee colony measurement system configured, accordingly, to send data in accepted format, or third-party services, like weather station data.

Benefit of the DW is that data are processed almost immediately by involving different models for data aggregation and reporting. Modular architecture of the solution ensures isolation boundaries both for reliability reasons, maintenance and development considerations.

LINKING REMOTE HARDWARE WITH CLOUD SOFTWARE

Remote hive monitoring systems (like Raspberry Pi based solution described previously in section 'Sensory hardware for bee colony monitoring') need special authentication mechanisms before sending data to the data warehouse. Since access to the Web API's interfaces are protected by Auth0 authentication and authorization service, non-interactive Machine-to-Machine authentication flow is required (https://auth0.com/docs/applications/machine-to-machine). During such flow Auth0 service provides access token (a credential) that is issued to an authorized device and must be included into each HTTP request to DW endpoints. The access token has an expiration time (for example, 24 hours) and should be eventually renewed by the device. Remote measurement system is sending HTTP POST request to DW data-in interface, including authentication token within request header and JSON formatted data as a body of the request. A temperature and humidity HTTP POST example is shown below (where <token> is issued by Auth0 service and source IDs are arbitrary identifiers used for mapping incoming data to beekeeping objects like hives):

```
POST /api/data HTTP/1.1
Host: example.host.com:port
Authorization: Bearer <token>
Content-Type: application/json

[{"sourceId": "temp-id-123",
  "values": [{"ts": "2018-10-10T23:06:00Z", "value": 33.2},
         {"ts": "2018-10-10T23:07:00Z", "value": 33.5}]},
 {"sourceId": "hum-id-234",
  "values": [{"ts": "2018-10-10T23:06:00Z", "value": 42.8}]}]
```

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Upon receiving such request, it is validated against registered/allowed devices, and only then it is converted to appropriate format and sent to DW Core. Data processing involves various stages of pre-aggregation and actions performed by DW Core (see Fig. 6): temporary incoming data storing (swamp), data flow management, data vault activation, etc. Example of temperature measurements pre-aggregated into hourly record is shown below:


```
{"_id" : "hive-549:2018101510",
  "count" : 5,
  "max" : 45.5,
  "min" : 39.099998474121094,
  "sum" : 213.39999771118164,
  "values" : {
        "15" : 44.400001525878906,
        "17" : 45.5,
        "20" : 41.599998474121094,
        "23" : 39.099998474121094,
        "27" : 42.79999923706055}}
```


Described DW was implemented as a set of microservices and modules, built using Spring Boot 2.0 (back-end) and Angular 6 with Bootstrap 4 framework (front-end). MongoDB, a NoSQL database was used as a persistent storage for metadata and measurements.

Developed solution was approbated by building end-to-end data flow from hive prototype located in Witzenhausen, Germany to DW cloud service (physically hosted on servers in Jelgava, Latvia). In addition, for testing purposes room micro-climate monitoring hardware prototype was adapted to send temperature and humidity measurements to DW using the same data-in interfaces. Both devices are sending their measurements according to their schedules and become available in DW user interface in a form of quick overview of latest values as well as detailed parametrized reports. During implementation and testing period, several new versions of device and DW software were deployed. Modular architecture and flexible interfaces contributed to fast new feature development and deployment cycle.

CONCLUSIONS

Development of the Precision Beekeeping direction is in active state nowadays, as many scientists and also industrial sector are heading toward development of solutions for improvement the management and monitoring of the apiary, minimising the beekeepers direct influence on the process.

Described systems and approach integrates two stages of the Precision Beekeeping, including data collection and data analysis. Third phase - application, remains still for the beekeeper.

Developed system should be used to minimise the number of manual bee colony inspections, which should lead to the minimisation of the impact to the bee colony health.

The advantage of developed system is the possibility to detect abnormal behaviour of the colony at an early stage giving the beekeeper the chance to save their colonies.

At this moment system's prototype is used in experimental apiary in Germany, but in the future systems will be installed in apiaries in Ethiopia and Indonesia.

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REFERENCES

Bencsik, M., Bencsik, J., Baxter, M., Lucian, A., Romieu, J. & Millet, M. 2011. Identification of the honey bee swarming process by analysing the time course of hive vibrations. *Computers and electronics in agriculture* **76**(1), 44–50. Available at: http://dx.doi.org/10.1016/j.compag.2011.01.004

Bommarco, R., Kleijn, D. & Potts, S.G. 2013. Ecological intensification: Harnessing ecosystem services for food security. *Trends in Ecology and Evolution* **28**(4), 230–238.

Ferrari, S., Silva, M., Guarino, M. & Berckmans, D. 2008. Monitoring of swarming sounds in bee hives for early detection of the swarming period. *Computers and electronics in agriculture* **64**(1), 72–77.

Fitzgerald, D.W., Murphy, F.E., Wright, W.M., Whelan, P.M. & Popovici, E.M. 2015. Design and development of a smart weighing scale for beehive monitoring. *In 26th Irish Signals and Systems Conference* (ISSC), pp. 1–6.

Gallai, N., Salles, J.M., Settele, J. & Vaissière, B.E. 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological economics* **68**(3), 810–821. Available at: http://dx.doi.org/10.1016/j.ecolecon.2008.06.014

Inmon, B.H. 2010. Data Warehousing, 2.0 Modeling and Metadata Strategies for Next Generation Architectures. *Architecture*, pp.1–13.

Kaplan, J. 2008. Colony Collapse Disorder. A Complex Buzz. *Agricultural Research Magazine* **56**(5), 8–11.

Klein, A.M., Vaissiere, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C. & Tscharntke, T. 2006. Importance of pollinators in changing landscapes for world crops. *Proceedings of the royal society B: biological sciences* **274**(1608), pp. 303–313.

Kviesis, A. & Zacepins, A. 2015. System architectures for real-time bee colony temperature monitoring. *In Procedia Computer Science*, **43**, pp. 86–94.

Meikle, W.G., Weiss, M., Maes, P.W., Fitz, W., Snyder, L.A., Sheehan, T., Mott, B.M. & Anderson, K.E. 2017. Internal hive temperature as a means of monitoring honey bee colony health in a migratory beekeeping operation before and during winter. *Apidologie* **48**(5), 666–680.

Meikle, W.G. & Holst, N. 2015. Application of continuous monitoring of honeybee colonies. *Apidologie* **46**(1), 10–22. Available at: http://link.springer.com/article/10.1007/s13592-014-0298-x

Ollerton, J., Winfree, R. & Tarrant, S. 2011. How many flowering plants are pollinated by animals? *Oikos* **120**(3), 321–326.

Pentjuss, A., Zacepins, A. & Gailums, A. 2011. Improving precision agriculture methods with multiagent systems in Latvian agricultural field. *In Proceedings of the 10th International Scientific Conference "Engineering for Rural Development."* Jelgava, Latvia, pp. 109–114.

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Potts, S.G., Ngo, H.T., Biesmeijer, J.C., Breeze, T.D., Dicks, L.V., Garibaldi, L.A., Hill, R., Settele, J. & Vanbergen, A. 2016. *IPBES:* Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production.

Ruan, Z.Y., Wang, C.H., Lin, H.J., Huang, C.P., Chen, Y.H., Yang, E.C., Tseng, C.L. & Jiang, J.A. 2017. An Internet of Things-Based Weight Monitoring System for Honey. International *Journal of Agricultural and Biosystems Engineering* **11(**6), 478–482.

Stalidzans, E., Zacepins, A., Kviesis, A., Brusbardis, V., Meitalovs, J., Paura, L., Bulipopa, N. & Liepniece, M. 2017. Dynamics of Weight Change and Temperature of Apis mellifera (Hymenoptera: Apidae) Colonies in a Wintering Building With Controlled Temperature. *Journal of Economic Entomology* **110**(1), 13–23. Available at: http://jee.oxfordjournals.org/lookup/doi/10.1093/jee/tow282

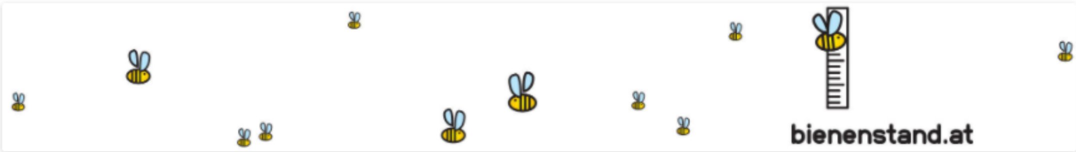
Zacepins, A., Brusbardis, V., Meitalovs, J. & Stalidzans, E. 2015. Challenges in the development of Precision Beekeeping. *Biosystems Engineering* **130**, pp.60–71.

2.7 October, 2019 – Das SAMS EU Projekt-Entwicklung nachhaltiger Bienenhaltung in Indonesien

Authors: Robert Brodschneider & Kristina Gratzer (2019)

Available online Bienen Aktuell

STARTSEITE WINTERVERLUSTE VON BIENENVÖLKERN UMFRAGE DATENBANK C.S.I. POLLEN ÜBER



Das SAMS EU Projekt – Entwicklung nachhaltiger Bienenhaltung in Indonesien

Hinterlasse eine Antwort

Smart Apiculture Management Services

Im von der **EU geförderten Projekt SAMS** (Smart Apiculture Management Services) wird die Imkerei in Entwicklungsländern gefördert. In diesem Artikel (auch in Bienenaktuell November 2019 erschienen) berichten wir über unsere Reise nach Indonesien.

Robert Brodschneider & Kristina Gratzer, Bienenaktuell 11/2019, Seite 18-21.

Das von der EU geförderte Horizon 2020 Projekt SAMS (Smart Apiculture Management Services, Grant Agreement N° 780755) wurde von der Deutschen Gesellschaft für Internationale Zusammenarbeit (GIZ) initiiert. Das Ziel dieses Projektes ist weniger wissenschaftlicher Natur, sondern Armutsbekämpfung durch die Entwicklung nachhaltiger Bienenhaltung in zwei für die GIZ bereits seit vielen Jahren bekannten Zielländern für Zusammenarbeit: Indonesien, mit Möglichkeit der Ausweitung auf ganz Süd-Ost-Asien, und Äthiopien, mit der Ausweitung auf Afrika südlich der Sahara. Das Projektkonsortium besteht von europäischer Seite neben der GIZ aus Partnern von der Lettischen Agrarwissenschaftlichen Universität, dem Witzenhausener Ableger der Universität Kassel, einer Forschungsstelle zu ökologischen Agrarwissenschaften und dem Institut für Biologie der Universität Graz. In den Zielländern sind unterschiedliche Institutionen involviert – von Forschungseinrichtungen bis hin zu Organisationen die sich mit Firmengründungen oder der Verbreitung von Wissen über die Biene kümmern. Aufhänger für dieses Projekt ist die erstmalige Entwicklung leistbarer elektronischer Stocküberwachungs-systeme in diesen Ländern, die mit Hilfe der Methode „Benutzer-zentriertes Design" in enger Zusammenarbeit mit lokalen Imkern und anderen Benutzergruppen entwickelt werden. Während in Europa solche Systeme, etwa Stockwaagen, kommerziell erhältlich und leistbar sind, stecken diese Entwicklungen, wie auch teilweise die moderne Bienenhaltung, in Afrika und

Suche

NEUESTE BEITRÄGE

- FAO Dokumente der Vereinten Nationen zur Imkerei
- Varroa Videos der Biene Österreich
- COLOSS online Konferenz 2020 nachsehen!
- Bienen Poster auf der Österreichischen (online) Citizen Science Konferenz!
- EU Projekt online Abschlusskonferenz!
- Junge Königinnen – geringere Verluste!?
- Publikation Winterverluste 2018/19 mehrerer Länder (internationaler Vergleich)
- Humming Room – Klangkunst im öffentlichen Raum (Graz)
- Kurzer Podcast zur Situation der Honigbiene im Frühjahr 2020
- Winterverluste 2019/20: Gesamtergebnis
- Publikation der 2018/19 Winterverluste
- Endstand Rückmeldungen 2020
- Gesucht: Bienenfoto als Titelbild für die Zeitschrift Bee World
- Vortragsvideo „Sterben die Bienen? Ein Faktencheck" bei „Skeptics in the Pub", Wien, 20.11.2019
- Publikation zur Pollendiversität in Österreich!

Asien noch in den Kinderschuhen. Als Beispiel sei hier die Vorgabe „Low Tech, Low Cost & Low Maintainance" genannt, wobei letzteres auch noch wenig Energieverbrauch inkludieren sollte. Ebenfalls ist bei diesem Projekt zu bedenken, dass Diebstahl von Bienenvölkern (inklusive etwaiger technischer Ausrüstung) vorkommen kann. Eine Erkenntnis dieses Projekts ist auch die Arbeit die in eine bessere Organisation der Imkerei, zum Beispiel durch Schaffung von Netzwerken oder Schulungsmaterialien, gesteckt werden muss.

Abb. 1. Das Team der Universität Graz durfte auch Proben von A. cerana mit nachhause nehmen.

Im Laufe des Projektes sind wir im Sommer 2019 nach Indonesien gereist, um die Situation vor Ort besser zu verstehen, Netzwerkarbeit zu leisten und natürlich um selbst mehr über die lokale Bienenhaltung zu erfahren (Abb. 1). Indonesien ist Heimat mehrerer Arten der Gattung *Apis*, allen voran der östlichen Honigbiene *Apis cerana* oder der Riesenhonigbiene *Apis dorsata*, aber auch anderer zur Honiggewinnung genutzter Bienenarten (Abb. 2). Unsere westliche Honigbiene *Apis mellifera* wurde zur profitablen Bienenhaltung eingeführt, hat sich aber noch nicht vollständig durchgesetzt. In anderen Worten: Es wird noch häufig mit *A. cerana* gearbeitet, auch wenn sich aufgrund fehlender Datenlage der cerana/mellifera Anteil an Völkern nicht genau bestimmen lässt (Abb. 3). Vom auf Seehöhe gelegenen Jakarta aus, fuhren wir per Zug in die auf fast 800 Meter Seehöhe gelegene „Stadt der Blumen" Bandung mit ihren zweieinhalb Millionen Einwohnern. Von den Blumen ist in der überfüllten und vom Individualverkehr stark geprägten Stadt nicht viel zu sehen. Allerdings ist das Klima sehr angenehm, weniger heiß und schwül als erwartet. Dort haben wir in einer Veranstaltung lokale Entscheidungsträger über den Projektfortschritt und vor allem über die Bedeutung der Bienen informiert. Dabei wurde auch ein offizielles Dokument zur Unterstützung der Bienen unterzeichnet, indem etwa die erstmalige Schaffung zweier mehrere Hektar großer Bienenschutzgebiete beschlossen wurde. Dieser Schritt wurde von den lokalen Bienenfreunden als ein sehr bedeutender erster Schritt zur öffentlichen Anerkennung der Bienen und der Imkerei gewertet, ist doch das Bewusstsein um die Bedeutung der Biene noch nicht so stark entwickelt wie in Europa. Eine weitere Veranstaltung war öffentlich zugänglich. Bei diesen Veranstaltungen wurden die Entwicklung der Imkerei in Indonesien, vor allem die Qualität des produzierten Honigs, der Erhalt der *A. cerana* Population aber auch die mangelnde Versorgung mit Trachtpflanzen sowie der Einsatz von Pestiziden diskutiert. Indonesien ist ein tropisches Land, allerdings gibt es wenig Kenntnis über die wichtigsten Trachtpflanzen, Massentrachten fehlen vielerorts. Die Abholzung des Waldes stellt ein weiteres Problem für das Land dar.

In der Region Ciwidey besuchten wir einen Betrieb der ausschließlich mit *A. cerana* arbeitet. Diese Biene ist etwas kleiner als *A. mellifera*, was sich auch in der für uns ungewohnt kleineren aber schön anzusehenden Zellgröße wiederspiegelt. Auch die Anzahl der Bienen in einem Volk ist geringer, verglichen mit *A. mellifera*. Um der Landwirtschaft (Reis, Tee, Kaffee, Gemüse) aus dem Weg zu gehen, hält der Imker Debby Bustomi zahlreiche Völker im Wald. Seine Wahl fiel auf *A. cerana*, weil diese seiner Meinung nach sehr effizient die Vegetation nutzen kann, und auch nur wenig Kapital zur Haltung dieser Biene notwendig ist – sein Völkerbestand speist sich aus dem Wald. Bienenstand ist für seine Aufstellungsart nicht der richtige Ausdruck, Bienenweg trifft es schon eher. Insgesamt etwa einhundert Völker sind entlang eines Trampelpfades alle fünfzig bis hundert Meter zu entdecken – ein Wunder, dass er tatsächlich alle, zum Teil in der Vegetation versteckten Völker findet. Auf Massenaufstellung verzichtet er genauso wie auf Ablegerbildung und Königinnenzucht. Die Beuten bestehen aus einer Einheit, die zum Schutz vor räuberischen Säugetieren auf hölzernen Pfählen montiert wurden. Die Pfähle wurden mit Öl bestrichen, um das Eindringen von Schädlingen, wie Kakerlaken oder Ameisen zu vermeiden. Einige der Beuten sind nicht besetzt, sondern entweder sind die Bienen abgeschwärmt – bei *A. cerana* kommen Fluchtschwärme, etwa durch Nahrungsmangel ausgelöst, vor – oder die leeren Kisten stehen Schwärmen zum Einzug zur Verfügung. Ein als weisellos identifiziertes Volk (mehrere Eier je Zelle deuteten sogar auf legende Arbeiterinnen hin) wurde prompt mit schlupfreifen Weiselzellen aus einem benachbarten Volk versorgt.

Abb. 2. Stachellose Bienen (links) werden oft gemeinsam mit A. cerona (rechts) geholten.

Abb. 3. Apis cerana Arbeiterinnen vor dem Flugloch

Wir konnten die (überaus friedlichen) *A. cerana* Völker auch bei ihrer Verteidigung gegenüber Hornissen beobachten. Nähert sich eine solche, schlagen die Bienen synchronisiert mit dem Abdomen – ein Verhalten dass sich auch noch kurze Zeit nach dem Hornissenangriff durch Handbewegungen vor dem Flugloch auslösen lässt. Die Honigernte findet etwa einmal pro Monat statt und der Honigertrag wurde uns mit etwa 2 kg pro Volk und Monat genannt – wobei allerdings nicht rund ums Jahr diese Menge zu ernten ist und von Rückgängen aufgrund der Abholzung des Waldes berichtet wird. Zur Ernte werden auch oft zahlreiche Helfer, unserer Meinung nach mehr als notwendig, angeheuert. Geerntet werden Wabenstücke (es wird ohne Mittelwände gearbeitet), geschleudert wird der Honig nicht, sondern entweder als Wabenhonig in Plastikdosen oder als Presshonig in Plastikflaschen verkauft (Abb. 4). Im Rahmen des Projektaufenthalts konnten wir einige einfach durchführbare Maßnahmen identifzieren, die eine merkbare Qualitätssteigerung ermöglichen würden. Aufgrund fehlender Organisationen wie Imkereivereinen, hat Debby eine Facebook Gruppe gegründet, die „Lebah madu Indonesia", oder „Indonesische Honigbiene", wo die mehr als 3200 Mitglieder bereits einen regen Austausch zu bienenrelevanten Themen betreiben.

Eine besondere Trachtpflanze stellt ein Baum aus der Familie der Hülsenfrüchtler dar: *Calliandra*, vermutlich *C. houstoniana* ist zwar in Indonesien ursprünglich nicht heimisch, der tropische Baum wurde aber eingeführt und versorgt Bienen sechs Monate im Jahr mit einem stark gelb gefärbten Nektar. Bäume dieser Gattung sind den Lesern vielleicht als Zierpflanzen unter der Bezeichnung „Puderquastenbäume" bekannt (Abb. 5).

Abb. 5. Der prächtige Blütenstand von Calliandra houstoniana dient den A. cerana Bienen in Indonesien als wichtige Nektarquelle.

Neben Bienen der Gattung *Apis* werden auch stachellose Bienen gehalten. Diese sind sehr viel kleiner als Vertreter von *Apis*, und lagern in ihren Nestern Honig in Töpfchen. Abbildung 6 zeigt ein Nest von stachellosen Bienen der Art *Tetragonula laeviceps* (frühere und in Indonesien heute noch geläufige Bezeichnung: *Trigona laeviceps*) denen kleine Holzboxen als Nistplätze angeboten werden. Die kleineren Kugeln beinhalten die Eier und Larven. Honig kann von diesen Völkern geerntet werden, mengenmäßig ist hier allerdings von einem Groscherlgeschäft zu sprechen. Gefangen werden die kleinen Völkchen mittels Bambusstämmen als Nistplatz. Wenn sich ein Volk in so einem Bambusstamm einmal angesiedelt hat, können die Völker dann umgesiedelt und bei ausreichender Stärke sogar geteilt werden.

Abb. 6. Einblick in ein Tetragonula laeviceps Volk. Zu sehen sind Brutzellen und Honigtöpfe (rechts unten).

Während unserer Zeit in Indonesien, konnten wir wertvolle Erfahrungen sammeln und uns mit örtlichen Imkern austauschen. Es war interessant zu erfahren, wie unterschiedlich nicht nur die Art der Bienenhaltung, angefangen von der Bienenbehausung über den Umgang mit den Bienenvölkern bis hin zur Honigernte ist, sondern auch, den Imkern vor Ort über die Schultern zu sehen. Wir lernten Indonesien als ein sehr gastfreundschaftliches Land kennen. Detaillierte Informationen zur Situation der Bienenhaltung in Indonesien finden Sie in unserem bereits vorab und frei zugänglich in der Zeitschrift Bee World erschienen Artikel von Gratzer et al. (2019). Außerdem werden auf der Projekt-Website https://sams-project.eu/ regelmäßige Newsletter veröffentlicht.

Literatur:

Kristina Gratzer, Fajar Susilo, Dwi Purnomo, Sascha Fiedler & RobertBrodschneider (2019) Challenges for Beekeeping in Indonesia with Autochthonous and Introduced Bees, Bee World, 96:2, 40-44.

Abstract of Development of sustainable beekeeping in Indonesia

In June/July 2019 the SAMS team visited a workshop in Bandung Indonesia. UNIGRA decided to write a travel report to share the great moments we had at the workshop itself and during our site visits to local beekeepers as well as to inform about the SAMS project, the beekeeping situation in Indonesia and the difference between a South-East Asian country and Austria in terms of beekeeping.. The publication was then published in Austria’s most popular beekeeping magazine “Biene aktuell” and as the magazine is only available for club members, the website bienenstand.at got the permission to publish the whole article online.

2.8 February, 2020 – Biosystems Engineering journal – Application of fuzzy logic for honey bee colony state detection based on temperature data

Authors: A.Kviesis , V.Komasilovs, O. Komasilova & A. Zacepins

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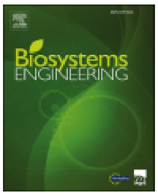

Research Paper

Application of fuzzy logic for honey bee colony state detection based on temperature data

Check for updates

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Fuzzy Inference System
Honey bee colony state

Since honey bees are one of the most important actors in the whole world, it is important to follow the life of these insects in order to preserve them from danger, via a range of risk factors such as Colony Collapse Disorder, pesticides, pests etc. Therefore it is important to identify any abnormalities inside the honey bee colony at an early stage, which may be possible using modern technologies e.g. monitoring systems, data processing, and analysis. This research proposes a solution for honey bee colony state identification using temperature data and fuzzy logic. The detection process proposes a Fuzzy Inference System that receives five input parameters and provides an output (defined as "assessment of the colony") pointing to (for now) three defined possible states – normal, death, and extreme. The rule base for the inference system was defined taking into account the knowledge of field experts, literature research, previous observations and was based only on temperature data and temperature changes inside the hive during different seasons. The proposed system proved to be quite robust, showing an accuracy value of ~98%, 100% precision and specificity, ~97% recall and ~98% F1 score when tested with validation set.

1. Introduction

Honey bees (*Apis mellifera* L.) are the most economically important managed insects (Southwick & Southwick, 1992; Aizen & Harder, 2009). Bees help to preserve wild biodiversity for 90% of species, and sustain the health and vitality of our food production. On the one hand, global honey consumption is increasing (Garcia 2018) but on the other hand, numbers of the bee colonies are decreasing (Meixner & VanEngelsdorp 2011; Moritz & Erler 2016). Mortality rates have reached 35% worldwide, and 44% of U.S. bee colonies were depleted during the winter of 2015/2016. A combination of multiple factors could explain the mass extinction of bees or CCD (Colony Collapse Disorder) phenomena observed worldwide, including exposure to pesticides, the practice of farmers growing a single crop, poor nutrition resulting from decreased biodiversity, and diseases and pests such as the Varroa mite. To deal with these problems, traditional beekeeping should be combined with innovations and technologies. The technological solutions and their implementation for honey bee colony real-time monitoring are summarised under the term precision beekeeping or precision apiculture. Precision

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beekeeping (PB), a branch of precision agriculture, is defined as an apiary management strategy aimed at minimising resource consumption and maximising the productivity of bees by monitoring individual bee colonies (Zacepins, Stalidzans, & Meitalovs, 2012). Similar to the precision agriculture concept, precision beekeeping is based on a three phase cycle: data collection, data interpretation and application. Data collection or the monitoring of honey bee colonies can provide important and up to date information about the state of the colony itself. Data obtained from monitoring requires complex processing and analysis and which would be time consuming when done manually. Implementation of a Decision Support System (DSS) can not only facilitate such a process, but also help to manage and control the operation of the system and, based on the results of analysis, inform interested persons about the necessary actions to take to affect the colony.

To date, bee colony monitoring and real-time data collection is the most developed phase in PB, as shown by numerous researches and commercial products regarding honey bee monitoring (Altun, 2012; Gil-Lebrero et al., 2017; Hudson & Hudson, 2014; Kviesis, Zacepins, Durgun, & Tekin, 2015; Meikle & Holst, 2015; Zacepins, Pecka, Osadcuks, & Kviesis, 2017; Zacepins, Pecka, Osadcuks, Kviesis, & Engel, 2017; Beebot, 2019; BuzzBox, 2019; Listening to, 2019; Welcome to, 2019). Monitoring can be considered as a means to get information about the processes inside a honey bee colony: when data are properly processed, it should be possible to identify state the colony is in – brood rearing, swarming, death etc. Such information is crucial for DSS for honey bee colony management to achieve the aims of PB.

Without sufficient data analysis it is not possible to get added value from different bee colony measurement systems. DSS can be adapted for PB to automatically analyse data and is considered as one of the sub-systems of the PB. Using different algorithms and models, DSS can help beekeepers to identify different bee colony states and warn about abnormal situations in the colony. Different bee colony states may have different levels of importance and can be marked with different level of reliability. DSS can process and combine bee colony data: mass, temperature, sound etc. DSS decisions can be split into two groups: individual rules, which are based on single colony monitoring, and differential rules, which are based on comparison between different colonies within one apiary.

The importance of data analysis has also been emphasised by Zacepins, Brusbardis, Meitalovs, and Stalidzans (2015) who noted that DSS development is usually the hardest task in PA field. In general DSS can be considered as any system that gives any kind of support to the user (Bruen, 2006). The decision, on the other hand, is a choice from many options, which should also include the option of doing nothing. Since the DSS provides many functionalities, this has led to simple but general DSS definitions. According to Marakas (2003), there are as many DSS definitions as one can find in articles and books on this topic. Decision support systems do not make decisions on their own, but rather help with intelligent decision making (Yourdon, 2006). The main characteristics of a DSS include: it supports the decision maker, but does not replace them; it supports all phases of the decision making process; it is under the DSS user's control; it is interactive and user friendly (Marakas, 2003; Power, Sharda, 2009).

In the beekeeping field, there have been some efforts regarding honey bee colony monitoring with data analysis and DSS development (Edwards-Murphy, Magno, Whelan, O'Halloran, & Popovici, 2016; Kridi, Carvalho, & Gomes, 2014; Kridi, de Carvalho, & Gomes, 2016; Kviesis, Zacepins, & Riders, 2015; Markovic, Pešović, Djurasevic, & Sinisa, 2016; BuzzBox, 2019).

Different methods can be used inside a DSS to utilise the knowledge about specific domains and formulate the rules. These can be in the form of a threshold, decision tree or other classification algorithms (Edwards-Murphy et al., 2016; Kviesis, Zacepins, & Riders, 2015; Markovic et al., 2016).

This research focuses on a development of a system for automatic honeybee state detection and proposes a novel way to detect bee behaviour changes in a beehive by using only temperature data and is a part of a proposed DSS. As stated by Baron, Achiche, and Balazinski (2001) fuzzy decision support systems can deal with incomplete and inaccurate knowledge, even for linear and non-linear problems.

2. Materials and methods

2.1. *Proposed DSS prototype concept for honey bee colony management*

The proposed DSS, which uses fuzzy logic as the knowledge processing unit, is based on three aspects: data, models and knowledge. Developed concept of a DSS decision making process is demonstrated in Fig. 1

The first stage is problem identification, which seeks to answer the following questions: "Who will be the decision maker? Who will be the stakeholder?" In this context these persons are beekeepers, but it should be noted that not every beekeeper is a specialist in information technology. Hence the problem should be looked at from the beekeeper's perspective. It is important for the beekeeper to maintain the colonies (overwinter)in order to gain maximum production (therefore detection of brood rearing, swarming and other states are essential). Since there are different honey bee colony states that can have an impact on the beekeeper's financial situation, several models should be developed in order to identify those states. As one approach, fuzzy logic is proposed and described further in this paper.

The next stage is alternative generation. Every detected bee colony state is analysed and necessary actions are determined: when to go to the apiary, when to do nothing. These are the two main alternatives the beekeeper can choose from. Then by using various methods, models can be developed to analyse possible alternatives. After that, the beekeeper chooses the alternative that fits them the best, implements it (performs a certain action) and then makes an assessment of the decision made. Assessment should be considered as one of the important steps in the decision making process, because it gives feedback about the whole process starting from problem identification to the alternative analysis. The assessment phase starts once the system has identified the problem and provided alternatives, and when the user has

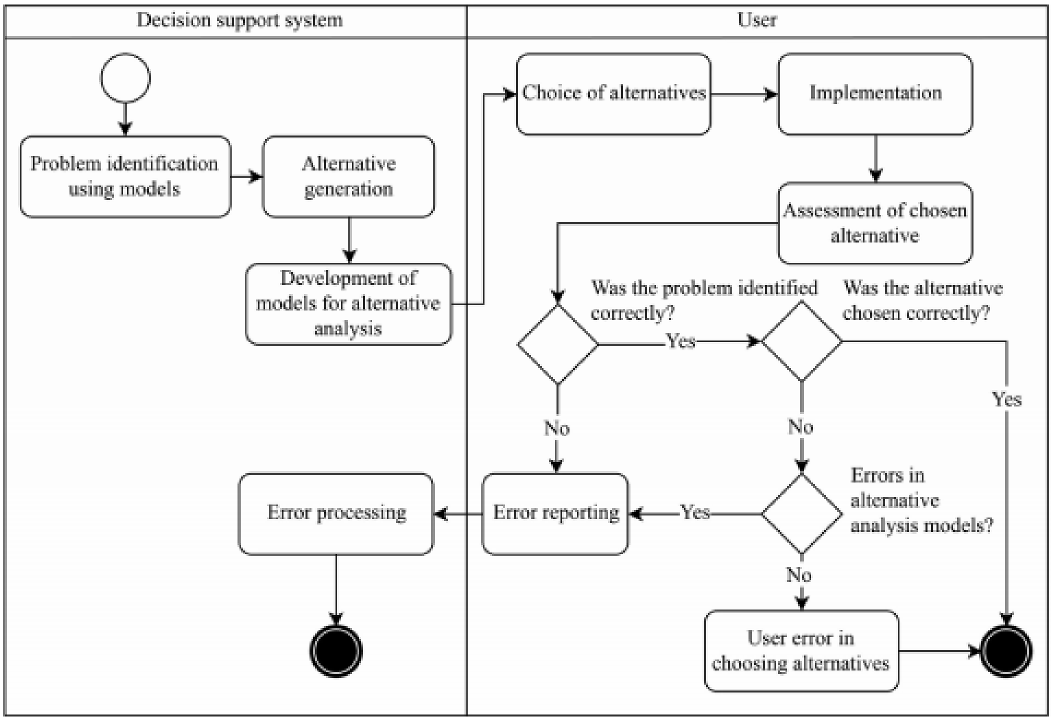

Fig. 1 – Proposed concept of a DSS decision making process.

taken a specific action. Thus the user (the beekeeper) can detect possible errors in specific steps (problem identification by the system, alternative selection), without having to repeat these steps in a cyclical manner. Therefore the beekeeper can assess whether the system has misidentified bee colony states or whether the beekeeper themself was making a mistake in choosing the correct alternative (since the user is the final decision maker in a DSS environment) or the system did not correctly analyse the alternatives. Feedback from the user takes the form of direct communication with the DSS system, where the user provides as much information as possible – hive number, when the problem was observed (date, time) and problem description. Afterwards the error processing block directly informs the system developers/maintainers of the need to update the knowledge bank, re-train models etc.

2.2. *Fuzzy logic*

The use of fuzzy logic for DSS and knowledge processing has been proposed in different fields. There are various studies where fuzzy logic has been implemented within a DSS in the medical domain (e.g. Ahmed, Westin, Nyholm, Dougherty, & Groth, 2006; Madaan & Garg, 2016). One of the few studies where fuzzy logic has been used in PB was by Bassford and Painter (2016) who explored fuzzy logic for bio-environment modelling in honey bee colony monitoring for early abnormality detection, specifically to predict colony collapse.

The idea of a fuzzy logic and fuzzy sets was first introduced by Zadeh (1965). Lately Fuzzy logic has grown in popularity and has been used in problem solving that deals with uncertainty and noise. In general, fuzzy logic deals with values between 0 and 1 (in a manner of "degree of truth") rather than exact values 0 or 1, like it is in Boolean logic. Therefore fuzzy logic is somewhat similar to human reasoning, e.g., in some reviews the respondents may answer with "rather no than yes", "partly agree" etc. And not with exact answers "yes" or "no". So fuzzy logic allows values to be defined that are between "yes" and "no", "true" and "false" etc. Fuzzy rules can be expressed as IF-THEN statements: *IF A THEN B*.

To determine the "degree of truth", fuzzy logic uses what are called membership functions. Membership functions can be expressed as $\mu_A : X \rightarrow [0, 1]$. These functions represent the fuzzy set graphically where x axis represents the universe of discourse, and y the degree of membership (a value between 0 and 1) (Alonso, 2015).

Membership functions can be represented in different shapes, but the most popular ones are triangle, singleton, trapezoidal, R-shape and L-shape (half of the trapezoidal), and Gaussian.

One of the main important units in a fuzzy logic system is the *Fuzzy Inference System* (FIS) (see Fig. 2) that transforms/maps the crisp input values into crisp output values by using fuzzy logic.

In general the whole Fuzzy Inference process consists of three steps – *fuzzification*, *rule evaluation* and *defuzzification*.

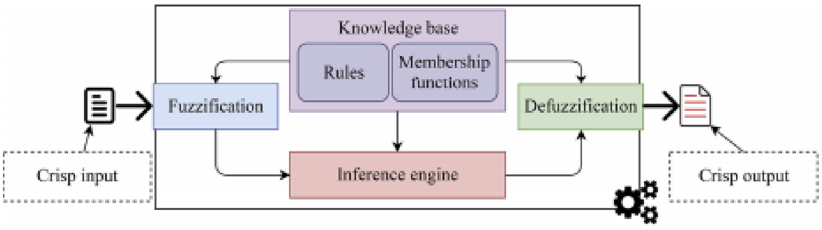

Fig. 2 – Concept of a fuzzy inference system (Mehran, 2008).

Fuzzification is a process when input variables that have crisp values (values that are within a range defined by the universe of discourse), are mapped through membership functions to a degree of truth (value between 0 and 1), that represents belonging to a specific fuzzy set. *Rule evaluation* contains several parts – the usage of fuzzy operators, implication method and rule outputs aggregation.

There are 3 main fuzzy operators (similarly to the de Morgan law) – union (*OR*), intersection (*AND*), complement (*NOT*) – that can be used in a fuzzy logic system. These operators, with 2 fuzzy sets A and B in universe X and their respective membership functions $\mu_A(x)$ and $\mu_B(x)$, can be written as:

$$A \cup B \rightarrow \mu_{A \cup B}(x) = \mu_A(x) \cup \mu_B(x) = \max(\mu_A(x), \mu_B(x)) \quad (1)$$

$$A \cap B \rightarrow \mu_{A \cap B}(x) = \mu_A(x) \cap \mu_B(x) = \min(\mu_A(x), \mu_B(x)) \quad (2)$$

$$\neg A \rightarrow \mu_{\neg A}(x) = 1 - \mu_A(x) \quad (3)$$

As can be seen, AND takes the minimum of the given values; OR – the maximum. When a single rule contains multiple variables, these operators determine the resultant value, which is further subjected to the implication method (usually *min* or *prod* function). For example, given results of fuzzification for *temperature* "high" (0.8) and *season* "winter" (0.6), the rule example below will return a value of 0.6 as a result of fuzzy operator "and" (corresponds to *min* operation):

IF *temperature* IS *high* AND *season* IS *winter* THEN *beestate* IS *extreme*.

Afterwards the result value (0.6) serves as an input to the implication process that will determine the output (consequent) of a specific rule by returning a fuzzy set. Implication process must be applied to every rule in the rule set. After all rules have been evaluated (implication methods applied), rule outputs should be combined (aggregated), where different methods can be used (*max*, *sum* or others).

Deffuzification turns a non-crisp value (a fuzzy set, to be exact) into a crisp output value. To perform this step, one must select a specific method – centre of gravity, mean of maximum, largest maximum, smallest maximum etc.

As stated by Sabri et al. (2013), fuzzy logic modelling provides advantages over traditional mathematical modelling, where fuzzy logic can combine human expert knowledge with numerical data and has the ability to approximate complex non-linear functions with simple models. Since the behaviour of the honey bee colony is non-linear, fuzzy logic is applicable to this specific task of recognising honey bee colony states from temperature changes.

Different honey bee colony states, depending on the sensors used, can be determined during bee colony monitoring (Zacepins et al., 2015). Relating to temperature monitoring, it is possible to determine if colony is alive, is in active brood rearing period, is swarming etc.

2.3. *Experimental site and technologies used*

The monitoring system was set up in Strazdu iela 1, Jelgava, Latvia (N 56° 39′ 45″ and E 23° 45′ 15″) to continuously measure temperature inside ten beehives from December 9th 2014 to January 1st 2017. All ten colonies were species of European honey bees (*A. mellifera*). Colonies were placed in Norwegian-type hive bodies made of wood with external size 470 × 470 × 270 mm and internal size 380 × 380 × 270 mm, with a wall thickness of 45 mm. One temperature sensor (Dallas DS18S20) per colony was installed inside the hive above the hive body (brood frames) as proposed by Stalidzans and Berzonis (2013) and Zacepins, Kviesis, Stalidzans, Liepniece, and Meitalovs (2016) and one temperature sensor was placed close to the hives (under a hood to avoid direct sunlight) to measure outside temperature.

Architecture of the monitoring system was based on 4th approach proposed by Kviesis and Zacepins (2015) and consisted of Raspberry Pi model B, high precision Dallas DS18S20 digital thermometers (11 in total) (forming a 1-*Wire* topological network) and a remote server. The digital thermometer DS18S20 has an accuracy of ±0.5 °C (from −10 °C to +85 °C) and communicates with a master device over a 1-*Wire* bus. Raspberry Pi model B was set up as a measurement device (and acted as 1-*Wire* master device) to gather and transmit data to a remote MySQL database every minute.

During the monitoring period, beekeepers at the experimental site made manual notes (date, approximate time, colony ID) of observed bee swarms and other bee activities during regular inspections (during early spring, manual inspections were more frequent in order to prepare the bees for the foraging season). Therefore beekeepers' observations were considered as ground truth observations.

The data set (hereinafter referred to as the "raw data set") used for further processing and analysis consisted of temperature data in the hives and outside taken every minute. The raw data set included fields such as–colony ID, date and time, temperature inside the hive and outside temperature. Afterwards the raw data set was split into different groups based on ground truth observations – swarming, normal (also split by seasons because temperature differs, i.e. summer (active brood rearing) and winter), death and abnormal.

2.4. *Automatic honey bee colony state detection process*

A honey bee colony state detection process using Fuzzy Inference System is demonstrated in Fig. 3:

During this research, two groups of rules were defined and implemented within a DSS prototype. The first group consists of differential rules, where the temperature difference between an individual colony and the whole apiary is compared. The second group are individual rules that are controlled by fuzzy logic. Defined rules allow the detection of bee colony death, normal state and extreme state (swarming; colony death; unknown (diseases, CCD etc.)), where the status of the colony is shown in a user interface (UI) together with additional notifications. It should be noted that, based on the information given by the DSS, the beekeeper is still the main decision maker.

2.5. *FIS structure and practical implementation*

The FIS described in this study uses only temperature data in order to detect honey bee colony states. Since the honey bee colony is self-regulating (maintains thermoregulation inside the hive), changes in colony behaviour should be reflected in temperature data. The prepared temperature data set used to construct and validate FIS is a time series consisting of temperature data collected every minute.

Java programming language and *jFuzzyLogic* (Cingolani, Alcala-Fdez, 2012; Cingolani, Alcalá-Fdez, 2013) library were used to implement FIS for honey bee colony state detection.

The raw data set was also used to define membership functions for FIS inputs (that are related to temperature data). FIS is constructed from five input and one output parameter. Each input parameter is processed (fuzzified) to determine its degree of truth – belonging to a specific fuzzy set. During the fuzzification process, several membership functions are used. These functions were defined taking into account multiple information sources – beekeepers' notes, knowledge and experience, scientific literature etc.

Input parameters, with relevant membership functions, are given below:

- temperature inside the hive – *th:{verylow, low, moderate, normal, high}*
  This parameter represents the temperature inside the hive during various seasons. Since the temperature varies between the seasons (e.g., during winter, a healthy colony temperature usually stays between 5 °C and 20 °C, but during summer, it is between 30 °C and 36 °C), five membership functions were defined;
- ambient temperature – *tout:{verylow, low, normal, high, veryhigh}*
  In total five membership functions were also defined for this input parameter, taking into account the seasonal temperature dynamics;
- difference between *th* and *tout* – *tdiff:{small, large}*
  This parameter represents the difference between the ambient temperature and the temperature inside the hive, which is important, e.g., in determining the possible decline of a bee colony;
- difference between temperature inside the same hive (current and previous hour) – *tdiff_hive:{small, large}*
  This parameter represents change in temperature inside the hive (comparing the current temperature with the average temperature 1 h ago);
- month – *season:{winter, spring, summer, autumn}*
  This parameter maps a specific month of the year to a season, because during seasons the actual temperature varies (there might be warm winter, cold autumn or spring seasons);

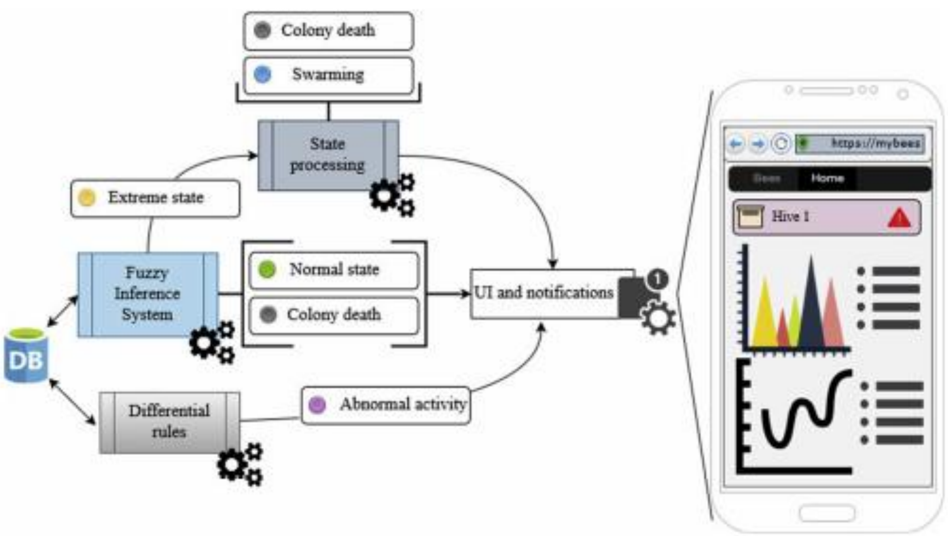

Fig. 3 – Representation of a honey bee colony state detection process.

The output of the FIS was defined by three membership functions – *states:{death, normal, extreme}*.

Since the output of the FIS is a crisp value, then in this context the output was considered and interpreted as "confidence of colony's healthiness" or "assessment of the colony". Fig. 4 shows the membership functions according to selected input parameters. It should be noted that "honey bee colony's death" can also be included in the state "extreme", since there are seasons where it is not that clear to detect colony's death by only looking at temperature data. However "extreme" state can also point to swarming (therefore needs to be identified using additional methods, as mentioned by Kviesis and Zacepins (2016) and Zacepins et al. (2016), or other abnormalities, like high temperatures during winter that could indicate some diseases or an early brood rearing period.

The raw data set was used to prepare a data set ("FIS data set") (see Table 1) that would allow the FIS rule set to be defined. The FIS data set was prepared by fusion of multiple information sources – raw data set, observations, literature and beekeepers' (experts) knowledge/experience – and combining them with ground truth, e.g., how the temperature (temperature range) changed when a particular bee state was observed during a specific season. The FIS data set was used as a fundamental building block for the FIS rule set (expressed as IF-THEN statements) that resulted in more than 150 rules. The complete schematic that shows several data set interactions to form the FIS rule set is given in Fig. 5.

Table 1 – Example of prepared FIS data set (fuzzified).

th	tout	season	tdiff	tdiff_hive	state
Low	very low	winter	large	small	normal
normal	very low	winter	large	large	extreme
normal	high	summer	large	large	extreme

A decision tree, in our case Iterative Dichotomiser 3 (ID3), algorithm was used to derive the fuzzy rule base. Such a method allows rules to be selected with higher information gain thus reducing the total number of elements in the FIS rule set. Several studies (Begenova & Avdeenko, 2018; Chaware & Lanjewar, 2014; Dhakal & Shrestha, 2016) have used decision tree algorithms for building the fuzzy rule base.

ID3 algorithm allows the root node of the decision tree, where the root node is the parameter that has the highest information gain, to be identified and then continues to build the decision tree, by determining the next attributes under respective branches. The ID3 stops tree building when a certain condition is met – all elements that are left belong to the same class, there are no more attributes or all branches have leaf nodes.

As a result, 37 rules were defined (see example below), where temperature difference inside the same hive (*tdiff_hive*) turned out to be the root node.

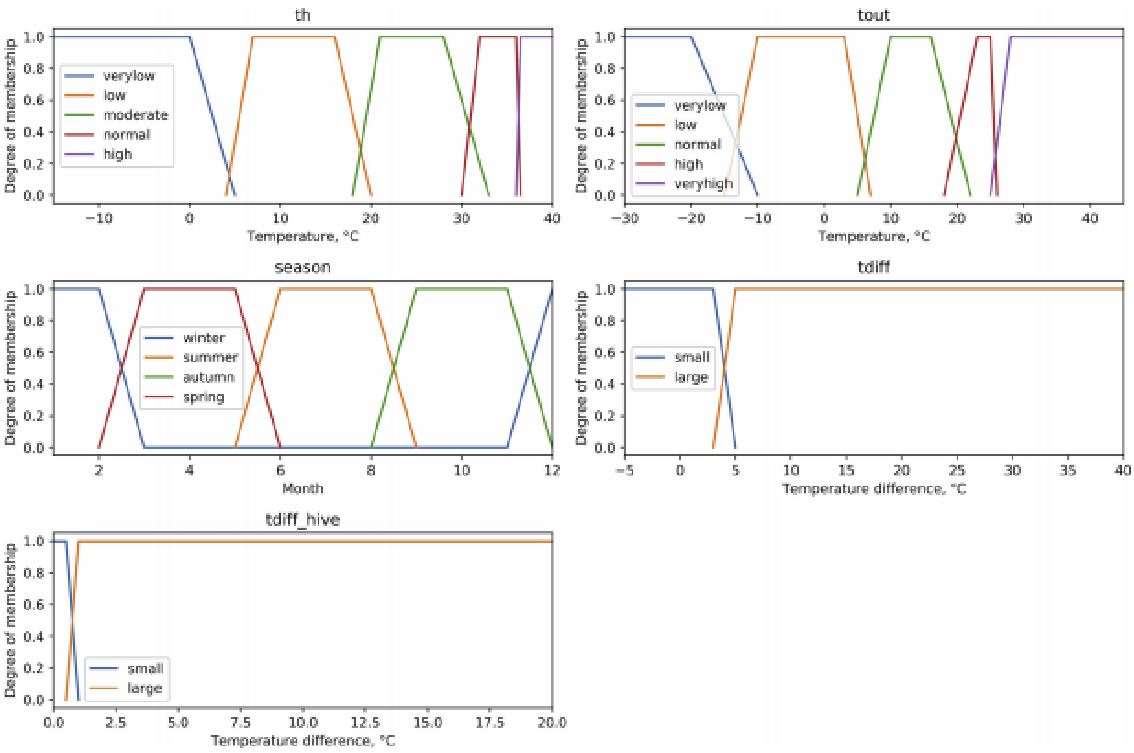

Fig. 4 – Defined membership functions for input parameters.

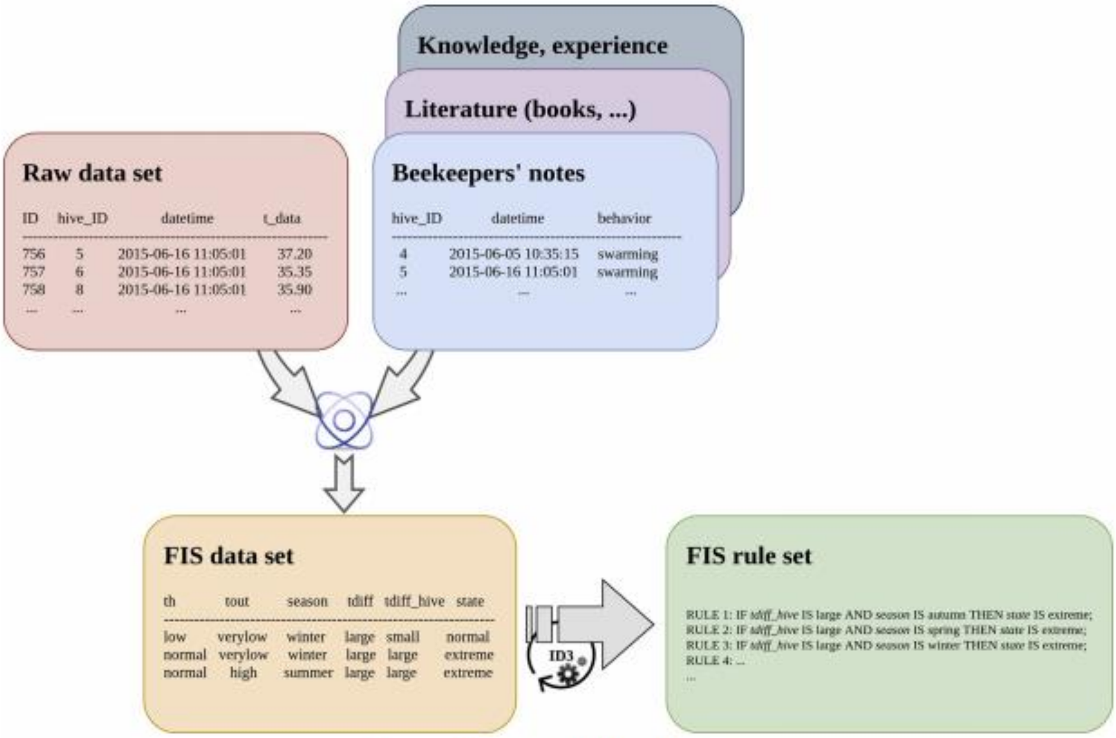

Fig. 5 – Schematics of FIS rule set creation.

Example of defined rules:

RULE 1: IF *tdiff_hive* IS large AND *season* IS autumn THEN *state* IS extreme;

RULE 2: IF *tdiff_hive* IS large AND *season* IS spring THEN *state* IS extreme;

RULE 3: IF *tdiff_hive* IS large AND *season* IS winter THEN *state* IS extreme;

RULE 4: IF *tdiff_hive* IS large AND *season* IS summer AND *tout* IS high AND *th* IS low THEN *state* IS extreme;

RULE 5: IF *tdiff_hive* IS large AND *season* IS summer AND *tout* IS high AND *th* IS normal THEN *state* IS death;

3. Results and discussion

3.1. *Developed FIS validation*

As there was few data available that characterise different colony states, the training data set was unevenly distributed. Training set of 35 records were used for FIS development, where ~25% were swarming patterns, ~55% were cases of bee normal behaviour throughout different seasons and ~20% were cases of bee death. The developed FIS was validated with data for in-hive temperature collected from honey bee colony. In total a data set of 90 records was selected (ground truth observations of various bee behaviours), where around 20% were swarming cases, ~40% were normal behaviour, ~15% death and ~15% abnormal cases. Since it is possible that a single measurement point can be faulty (bees can heat the sensor by "sitting" on it or there can be a technical reason), the median value was taken from the last 5 measurements.

It was observed that, after development and tuning, the FIS could detect all swarming cases, where Fig. 6 represents one such case.

During swarming, there is a temperature rise (Fig. 6), and at this point the FIS value fell to 50%, indicating an "extreme" state. Therefore this case should be processed further by a separate state processing module (see Fig. 3) to test if it corresponds to swarming pattern. Since there can be cases (as was observed in one case during the month of August, for which, unfortunately, the cause could not be clarified), when rapid increase in temperature does not point to swarming, it is not enough to apply a threshold-base algorithm, because, referring to swarming, a specific temperature pattern is formed. Such case should be processed separately, e.g., via state processing module, as shown in Fig. 3. This processing module could have a pattern recognition method to recognise, e.g., swarming state.

The data set included data about the honey bee colony during winter season where the colony was mostly in normal state, but with some exceptions when temperature spikes

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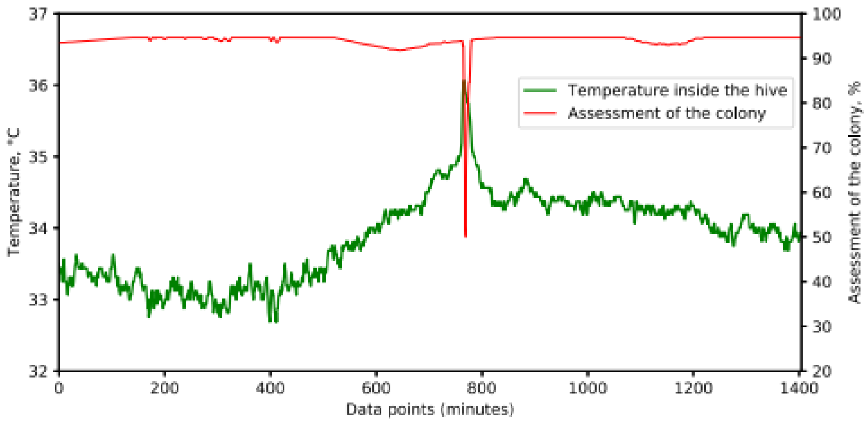

Fig. 6 – Successful swarming detection by FIS (temperature data throughout the day of 01-JUN-2015).

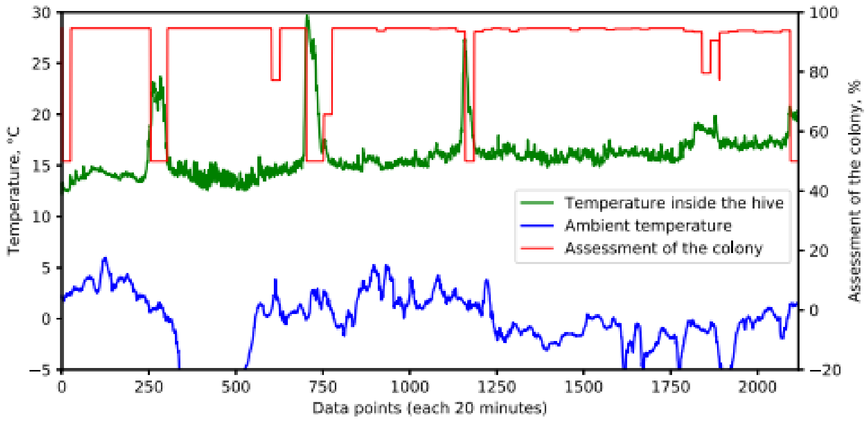

Fig. 7 – Temperature spikes during wintering season (data for the period from 01-JAN-2015 to 30-JAN-2015).

were observed (temperature increased by 10 °C). All these cases were successfully identified by the FIS, signalling that the colony is in "extreme" state. Those spikes clearly point to some stressful factors (see Fig. 7).

Regarding honey bee colony death, the system was able to point to some instabilities in temperature data (see Fig. 8). The temperature tended to decrease until it started to resemble the ambient temperature curve. The FIS warned that the colony is in

the extreme state quite early and showed that the colony died (colony assessment was under 40%), when the temperature was almost identical to the ambient temperature.

FIS performance was evaluated using confusion matrix that used 4 different value combinations (Joshi, 2016; Narkhede, 2018):

Figures above (Figs. 6-8) indicates that application of Fuzzy logic can detect abnormalities at a relatively early stage. By setting appropriate threshold values, the beekeeper may be alerted to the occurrence of specific events. This raises an important question for discussion - what should these values be so that the beekeeper could react accordingly? As it can be concluded from the FIS validation results, assessment value around 50% clearly shows the existence of abnormality, therefore setting the threshold value to 50% should be a very strong measure of confidence.

FIS performance was evaluated using confusion matrix that used 4 different value combinations (Joshi, 2016; Narkhede, 2018):

- true positive (TP) – an actual event occurred and it was predicted as occurring;
- false negative (FN) – an actual event occurred, but was misidentified;

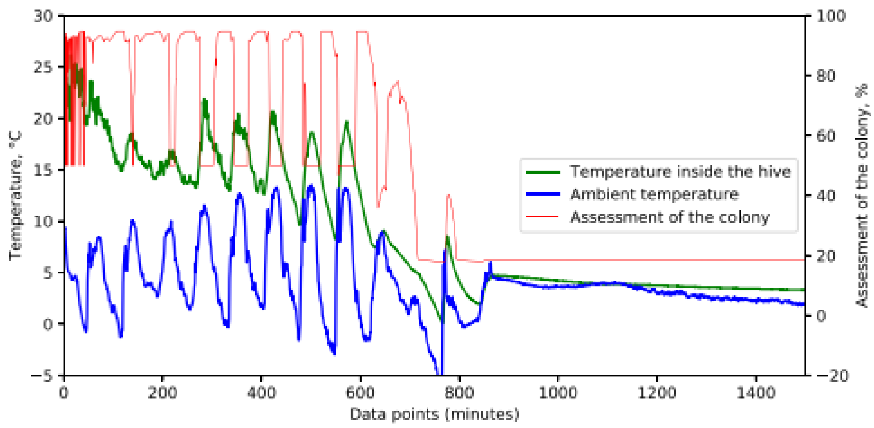

Fig. 8 – Identification of possible bee colony death (data from 11-MAR-2015).

- false positive (FP) – an event did not occur, but was predicted as occurring;
- true negative (TN)– an event did not occur and was predicted as non-occurring.

Model performance was calculated (formulae 4.-8.) by determining five measures. According to Joshi (2016) and Saxena (2018):

- accuracy (ACC) – ratio of correct observations to all observations. This measure does not always describe the performance of the model best, especially in cases, when the test data set is unevenly distributed;

$$ACC = (TP + TN) / (TP + FP + FN + TN) \quad (4)$$

- recall (REC) – ratio of correctly predicted positive observations to all positive observations. This measure shows how well the model has recognised relevant results. One could interpret this as follows: "From all observed events that occurred, how many were predicted as occurring?";

$$REC = TP / (TP + FN) \quad (5)$$

- precision (PRC) – ratio of correctly predicted positive observations to the total predicted positive observations – the lower the FP, the higher the precision. This could be interpreted as follows: "From *n* predicted events, how many did actually occur?";

$$PRC = TP / (TP + FP) \quad (6)$$

- specificity (SPC) – ratio of actual negative cases to the correctly predicted negative cases;

$$SPC = TN / (FP + TN) \quad (7)$$

- F1 score – measure that combines both recall and precision. If the model is performing very well, this measure is of a higher value. Calculation of F1 score is based on harmonic means and can be considered (Joshi, 2016) to be a more useful model describer, especially, if the test set is unevenly distributed.

$$F1 = (2 * REC * PRC) / (REC + PRC) \quad (8)$$

After FIS validation, confusion matrix was evaluated. The FIS showed an accuracy value of ~98%, 100% precision and specificity, ~97% recall and ~98% F1 score. The performance evaluation demonstrates that the FIS operates in a correct and stable manner (~98%) identifying changes in honey bee colony state.

In a fully constructed DSS, the user will be provided with several options to analyse alternatives, e.g., in the case of swarming, he would be able to evaluate if it would pay off (what are the costs, if the system failed to correctly detect swarming and the beekeeper went to the apiary; what are the benefits if the system detected swarming correctly and the swarm was caught etc.) to go to catch the swarm (depending on the distance, travel costs, person costs etc.). Since this study is more focused on the state detection process, this part (alternative analysis) of the DSS is not addressed here.

3.2. DSS user interface

An important point of discussion is the UI and user (beekeeper) interaction with the developed solution for honey bee state identification. Since the developed FIS is the knowledge processing block of a DSS, it is crucial for the user to properly use the benefits of the system, meaning that the user interface should provide all the necessary information for apiary management. It is important to point out that the output of the developed FIS will not be directly shown to the user, but through a separate UI layer, so the user will be shown the detected state and its importance. The UI should be developed carefully, taking into account the beekeepers' needs and local context. For some beekeepers' it would be enough to just show colony state with notifications, but for some beekeepers, who are also willing to understand how different parameters change inside the hive, it would be better to also provide more detailed data display.

4. Conclusion

The developed FIS for early identification of honey bee state proved to operate in a robust manner, and instabilities were only observed in special cases that need to be studied in more detail. The presented prototype for honey bee state identification provides a convenient way to modify or expand the rules and input variable definitions.

In the future, it is planned to extend the FIS with additional rules based on other monitoring parameters (e.g. audio data, weight), which will extend the possibility to detect more bee colony states.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

Ahmed, M., Westin, J., Nyholm, D., Dougherty, M., & Groth, T. (2006). A fuzzy rule-based decision support system for Duodopa treatment in Parkinson. In *23rd annual workshop of the Swedish artificial intelligence society*. Umeå. May, 2006.

Alonso, S. K. (2015). *Membership functions*. http://www.dma.fi.upm.es/recursos/aplicaciones/logica_borrosa/web/fuzzy_inferencia/funpert_en.htm. (Accessed 10 October 2018).

Altun, A. A. (2012). Remote control of the temperature-humidity and climate in the beehives with solar-powered thermoelectric system. *Journal of Control Engineering and Applied Informatics, 14*(1), 93–99.

Baron, L., Achiche, S., & Balazinski, M. (2001). Fuzzy decision support system knowledge base generation using a genetic algorithm. *International Journal of Approximate Reasoning, 28*(2), 125–148.

Bassford, M., & Painter, B. (2016). Intelligent bio-environments: Exploring fuzzy logic approaches to the honeybee crisis. In *Intelligent environments (IE), 2016 12th international conference on* (pp. 202–205).

Begenova, S. B., & Avdeenko, T. V. (2018). Building of fuzzy decision trees using ID3 algorithm. In *Journal of Physics: Conference Series* (Vol. 1015, p. 22002).

Bruen, M. (2006). Introduction to decision support systems. In *River basin modelling for flood risk mitigation* (pp. 235–248). London: Taylor & Francis.

Chaware, A., & Lanjewar, D. U. A. (2014). ID3 derived fuzzy rules for predicting the students acedemic performance. IOSR Journal of Computer Engineering, 16(6), 53–60.

Dhakal, V., & Shrestha, S. (2016). *Performance of ID3 derived fuzzy rule based multicriteria vertical handover decision algorithm*.

Edwards-Murphy, F., Magno, M., Whelan, P. M., O'Halloran, J., & Popovici, E. M. (2016). b+ WSN: Smart beehive with preliminary decision tree analysis for agriculture and honey bee health monitoring. *Computers and Electronics in Agriculture, 124*, 211–219.

Gil-Lebrero, S., Quiles-Latorre, F., Ortiz-López, M., Sánchez-Ruiz, V., Gámiz-López, V., & Luna-Rodríguez, J. (2017). Honey bee colonies remote monitoring system. *Sensors, 17*(1), 55.

Hudson, G., & Hudson, C. (2014). *Bee hive monitor | OpenEnergyMonitor*. from http://openenergymonitor.org/emon/beemonitor. (Accessed 7 February 2014).

Joshi, R. (2016). Accuracy, precision, recall & F1 score: Interpretation of performance measures. https://blog.exsilio.com/all/accuracy-precision-recall-f1-score-interpretation-of-performance-measures/. (Accessed 12 September 2018).

Kridi, D. S., Carvalho, C. G. N.de, & Gomes, D. G. (2014). A predictive algorithm for mitigate swarming bees through proactive monitoring via wireless sensor networks. In *Proceedings of the 11th ACM symposium on Performance evaluation of wireless ad hoc, sensor, & ubiquitous networks* (pp. 41–47).

Kridi, D. S., de Carvalho, C. G. N., & Gomes, D. G. (2016). Application of wireless sensor networks for beehive monitoring and in-hive thermal patterns detection. *Computers and Electronics in Agriculture, 127*, 221–235.

Kviesis, A., & Zacepins, A. (2015). System Architectures for real-time bee colony temperature monitoring. *Procedia Computer Science*, 43C, 86–94. https://doi.org/10.1016/j.procs.2014.12.012.

Kviesis, A., & Zacepins, A. (2016). Application of neural networks for honey bee colony state identification. In *Carpathian control conference (ICCC), 2016 17th international* (pp. 413–417).

Kviesis, A., Zacepins, A., Durgun, M., & Tekin, S. (2015). Application of wireless sensor networks in precision apiculture. In *Proceedings of the 14th international scientific conference engineering for rural development* (p. 6).

Kviesis, A., Zacepins, A., & Riders, G. (2015). Honey bee colony monitoring with implemented decision support system. In *Proceedings of the 14th international scientific conference engineering for rural development* (p. 6).

Welcome to Solutionbee. (2019). https://solutionbee.com/.

Madaan, V., & Garg, A. (2016). DSSBD: Fuzzy rule based decision support system for blood disease diagnosis. *International Journal of Control Theory and Applications, 9*(11), 5149–5158.

Markovic, D., Pešović, U., Djurasevic, S., & Sinisa, R. (2016). Decision support system for temperature monitoring in beehives. *Acta Agriculturae Serbica, 21*(42), 135–144.

Mehran, K. (2008). Takagi-Sugeno fuzzy modeling for process control. *Industrial Automation, Robotics and Artificial Intelligence (EEE8005)*, 262.

Meikle, W. G., & Holst, N. (2015). Application of continuous monitoring of honeybee colonies. *Apidologie, 46*(1), 10–22.

Sabri, N., Aljunid, S. A., Salim, M. S., Badlishah, R. B., Kamaruddin, R., & Malek, M. F. A. (2013). Fuzzy inference system: Short review and design. *International Review of Automatic Control, 6*(4).

Saxena, S. (2018). *Precision vs recall*. from https://towardsdatascience.com/precision-vs-recall-386cf9f89488. (Accessed 12 September 2018).

Stalidzans, E., & Berzonis, A. (2013). Temperature changes above the upper hive body reveal the annual development periods of honey bee colonies. *Computers and Electronics in Agriculture, 90*, 1–6.

Beebot. (2019). https://pollenity.com/product/beebot/.

Listening to bees. (2019). http://www.arnia.co.uk/.

Zacepins, A., Brusbardis, V., Meitalovs, J., & Stalidzans, E. (2015). Challenges in the development of precision beekeeping. *Biosystems Engineering, 130*, 60–71.

Zacepins, A., Kviesis, A., Stalidzans, E., Liepniece, M., & Meitalovs, J. (2016). Remote detection of the swarming of honey bee colonies by single-point temperature monitoring. *Biosystems Engineering, 148*, 76–80.

Zacepins, A., Pecka, A., Osadcuks, V., & Kviesis, A. (2017). Development of internet of things concept for precision beekeeping. In *Carpathian control conference (ICCC), 2017 18th international*.

Zacepins, A., Pecka, A., Osadcuks, V., Kviesis, A., & Engel, S. (2017). Solution for automated bee colony weight monitoring. *Agronomy Research, 15*(2), 585–593.

Zacepins, A., Stalidzans, E., & Meitalovs, J. (2012). Application of information technologies in precision apiculture. In *Proceedings of the 13th international conference on precision agriculture (ICPA 2012). Indianapolis, USA*.

Zadeh, L. A. (1965). Fuzzy sets. *Information and Control, 8*(3), 338–353.

BuzzBox. (2019). https://www.osbeehives.com/.

2.9 June 2020 – Bachelor Thesis Latvia – Alternative Energy Uses in Precision Beekeeping evaluation

Authors: student O. Volkovs (supervised by Aleksejs Zacepins)

Available: Volkovs O. IT Alternative Energy Uses in Precision Beekeeping evaluation.: Bachelor's paper. – Jelgava: LUA, 2020. – 60 pp., 29 fig., 1 tab., 75 references, 2 appendices.

Annotation of the bachelor's work:

The first chapter of the paper investigates alternative energy types and their application in Latvia and in the world. The volume of energy consumption in different sectors of the economy is analysed. Renewable energy sources such as solar, wind and tidal power are considered. The use of solar energy, which is the most financially available in Latvia and in the world and its possibilities, is analysed.

The second chapter deals with the beekeeping sector, its characteristics and prevalence. The problem areas of the industry, where bee monitoring techniques are important, old-fashioned maintenance methods, and extensive bee losses in several parts of the world are analysed.

Analysing the possible solutions for bee monitoring, the analysis of technological solutions was carried out, where a system prototype was developed with the help of Raspberry PI3, Thingspeak, solar cells, sensors. Functional capabilities and working principles of prototype are evaluated. The principles of interaction of prototype components are described.

During the experimental implementation of the bee monitoring system prototype, the usefulness of the obtained data for further processing and application was evaluated. The obtained data indicate changes in humidity and temperature per unit of time. Data analysis capabilities of prototype refer to the observation of data in units of time (hours, days). Further processing of data by exporting to CSV file and freeware R is analysed.

As a result of this work a prototype of bee colony surveillance was developed. By implementing the Raspberry PI3, Thingspeak, solar panels, sensor interaction process, prototype functionality is provided. Prototype operation provides data storage, graphical representation and retrieval in CSV files.

Further development of the work focuses on the development of a prototype by developing advanced decision support for beekeepers in the event of unforeseen and crisis situations (reported data).

This bachelor work is developed within the SAMS project:

Darbs ir izstrādāts Horizon 2020 projekta SAMS (Smart Apiculture Management Services, Nr. 780755) ietvaros. Un uzdevums par saules enerģijas novērtēšanu tika definēts balstoties uz projekta uzdevumiem.

2.10 September 2020 – Monitoring system for remote bee colony state detection

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Monitoring System for Remote Bee Colony State Detection

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Abstract. Honeybees are the main pollinators for agricultural and horticultural plants. They help at least 30% of the worlds crops and 90% of the worlds wild plants to thrive via cross-pollination. To minimise the effect of on-site colony inspections application of Precision Beekeeping solutions are becoming increasingly frequent. Real time, remote monitoring of the colonies using ICT can help the beekeepers to detect abnormalities and identify states of the colony. For successful implementation of the Precision Beekeeping system development of the bee colony monitoring hardware solution and computer software for data collection and further analysis is needed. This paper describes authors developed bee colony monitoring system for the remote bee colony state detection. Bee colony weight together with temperature are the key metrics for state and behaviour analysis. Hardware of the developed monitoring system is based on the popular ESP8266 low-cost Wi-Fi microchip. Weight is measured using single point load cell with possibility to measure weight up to 200kg, which is enough for the bee colony measurements. Data transfer from the remote apiary is provided by the external 3G router. For data storage and analysis cloud-based data warehouse was developed. Collected data is accessible in the web system in real time. In addition, web tool for system power consumption and battery life evaluation was developed to assess monitoring system sustainability. Described monitoring system is developed within the Horizon 2020 project SAMS, which is funded by the European Union within the H2020-ICT-39-2016-2017 call. To find out more visit the project website https://sams-project.eu/.

Keywords: Precision Beekeeping, Precision Apiculture, bee colony monitoring, bee colony weight measurements, SAMS project

1. Introduction

Pollination of agricultural and horticultural plants is crucially necessary for human food supply. Insects are the main pollinators, and honey bees are the most widespread and active insects worldwide (Bradbear, 2009; Breeze et al., 2011).

Beekeeping is one of the traditional branches of the agriculture and recently Precision Beekeeping (Precision Apiculture) has been defined, as apiary management strategy based on individual bee colony monitoring (Zacepins et al., 2015). One of the main objectives of the Precision Beekeeping is to assist the beekeepers with on time detection of bee colony states. To detect different states of the bee colonies different sensors can be used and data should be centrally collected and analysed. Behaviour and state of bee colonies can be monitored by the use of temperature, humidity, acoustics, video, weight and other sensors (Meikle and Holst, 2015). Continuous and real-time monitoring of colony parameters is becoming feasible also for smaller beekeepers as the cost of the end systems are decreasing while their precision and valuable outcome are increasing. It is evaluated that implementation of Precision Beekeeping system can lead to economic benefit for the beekeepers (Zacepins et al., 2020). Another benefit of the remote bee colony monitoring is the reduction of the number of manual on-site inspections thus decreasing the effect of bee disturbance. Frequent, physical inspections of bee colonies interferes with bees normal living and can cause additional stress, that negatively affects the whole colony productivity (Komasilovs et al., 2019; Zabasta et al., 2019). As well the distributed locations of apiaries are frequently present, and thus, indicate the need to ease the monitoring of animals in a 24/7 mode, which can benefit from advanced intelligent ambiance technologies (Zgank, 2019).

There are many studies about bee colony parameter monitoring and it is concluded that weight and temperature are the main ones as costs compared to outcome information is adequate. Bee colony weight monitoring provides one of the most important kinds of data beekeeper can have about the colonies (Fitzgerald et al., 2015). Automated weight systems can supply the beekeeper with important information on several important events from the honey bee colonies (Buchmann and Thoenes, 1990; Meikle et al., 2006; Meikle et al., 2008). Weight is related to such important activities of the bee colony like starting of nectar collection, resource consumption by the colony indicating the need of additional feeding. Some developed solutions are described in scientific publications (Fitzgerald et al., 2015; Ochoa et al., 2019; Terenzi et al., 2019; Zabasta et al., 2019; Zacepins et al., 2017). Second important parameter of the bee colony is temperature, as bees can regulate temperature inside the hive (Southwick, 1992). Temperature measurements of bee colonies have the longest history and nowadays, bee colony temperature measurements seem to be the simplest and cheapest way to monitor bee colonies (Zacepins and Karasha, 2013). Basically, temperature sensor usually is added to every bee colony monitoring device. The monitoring of honeybee colonies over long periods of time can result in long-term data for better analysis and understanding of the colony behaviour (Kviesis et al., 2020; Lecocq et al., 2015; Odoux et al., 2014; Simon-Delso et al., 2014).

Aim of this paper is to describe the developed monitoring system for honey bee colony state detection using single point load cell and ESP8266 low-cost Wi-Fi microchip.

Within this research authors used several modern computing methods, including but not limited to hardware prototyping and 3D designing, automatic data collection about hardware power consumption patterns, actual web system development and data flow control methods etc.

Development of the bee colony digital monitoring system is done within the Horizon 2020 project SAMS. A combined biological, sociological and technical approach is made within the SAMS - Smart Apiculture Management Services - project (https://sams-project.eu/). The SAMS project is funded by the European Union within the H2020-ICT-39-2016-2017 call. It enhances international cooperation of ICT and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".

2. Developed digital system for bee colony monitoring

As discussed in the introduction the main parameters of the bee colonies are weight and temperature. Thus, digital system for those parameter monitoring is developed within this research. The high costs and inapplicability for outdoor conditions of continuously loaded general purpose electronic scales limits their application in Precision Beekeeping.

Authors of this research developed prototype of honeybee colony digital monitoring system based on single point load cell (BOSCHE Wagetechnik Single point load cell H30A, https://www.bosche.eu/en/scale-components/load-cells/single-point-load-cell/single-point-load-cell-h30a) with max load of 200kg and ESP8266 low-cost Wi-Fi microchip. ESP8266 has a full TCP-IP stack and microcontroller capability. ESP8266 CPU frequency and built in memory is enough to perform intended task of collecting bee colony data and transferring it to the remote storage for further processing. In addition to weight sensor, two other sensors are added to the system for bee colony temperature and environmental humidity and temperature monitoring. Environmental parameter monitoring is essential component too, because sometimes to correctly interpret bee colony state it is necessary to know the outside conditions (Kviesis et al., 2020).

Chosen load cell is an analogue one and for usage in digital monitoring system it is needed to convert analogue signal to digital. For getting the weight data analogue/digital converter HX711 is used. Measurement node itself is battery powered (by 4x1.2V NiMH rechargeable batteries). For testing purposes, the Wi-Fi router (HUAWEI E5330) was powered from power grid (220V AC) via 5V micro USB adapter that can be substituted also by a suitable 5V battery (or solar powered solution). As well for data sending to the remote server Wi-Fi network (provided by the 3G router) is used, but it can be easily substituted by mobile network adding additional module to the ESP microchip or even data transfer using LoRaWAN (Zacepins et al., 2018) can be implemented. At this moment system is assembled on the printed circuit board without any casing, but after tests end market prototype will be developed. Developed system's architecture is based on proposed approach by (Kviesis and Zacepins, 2015) where an individual bee colony measurement node sends sensor data to the remote server via wireless or mobile network communication.

Mounting of the single-point load cell is performed based on instructions provided by the manufacturer. Load cell is mounted between two metal plates (10cm x 15cm), and afterwards metal plates are screwed to the plywood plates (50cm x 50cm). Beehive can be placed directly on the platform or some additional wooden planks can be used. Mounting of the load cell is shown in Figure 1.

Usually beekeepers are not ready to invest much in the digital solutions, thus economic aspect of the system is very crucial and system costs should be as minimal as possible. This proposed solution evolved from authors previous researches and solution based on four small load cells (Zacepins et al., 2017) and weighting system based on a Raspberry Pi single board computer (Komasilovs et al., 2019).

Usage of cheaper microchip allowed to decrease the overall costs of the system. In authors case costs for system components and additional materials are summarised in Table 1.

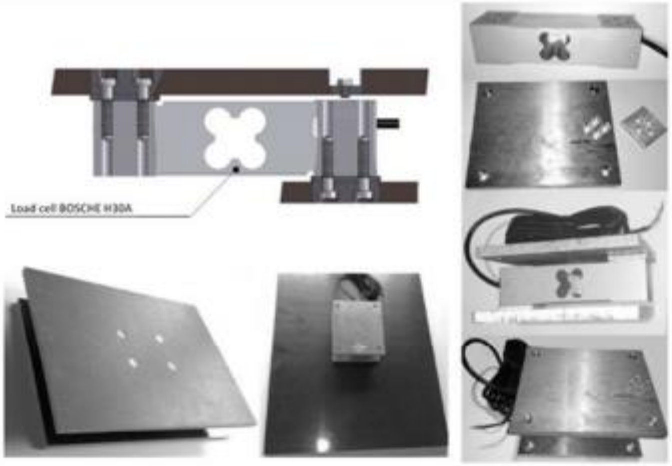

Fig. 1. Load cell assembling process

Table 1. System components with unit costs

Nr.	Name of the component	Cost (in EUR)
1	BOSCHE Wagetechnik Single point load cell H30A (200kg)	50.00
2	Platform for load cell	50.00
2.1	Plywood	14.00
2.2	Metal plate	14.00
2.3	Screws	2.00
2.4	Assembling costs	20.00
3	ESP8266 ESP-12E + adapter plate	13.00
4	Temperature sensor DS18B20	4.00
5	Humidity and temperature sensor DHT22	7.00
6	A/D converter Sparkfun HX711	11.00
7	3G router Huawei E5330	37.00
8	Additional components (PCB, wires, resistors, capacitors, connectors, etc.)	10.00
9	Rechargeable batteries Ni-MH Eneloop 1900 mAh (4x)	10.00

The calculated costs for one developed system are 192.00 EUR. System installation, maintenance, data storage, SIM card with appropriate data plan and usage of the web system, usage of alternative power supply is not considered in those calculations. It should be mentioned that some components are optional, like 3G router can be dismissed if there are constant Wi-Fi connection at the apiary site.

System can take measurements based on measurement intervals, that can be configured individually based on required information that should be gained from the system and depending on bee colony states, that could be detected. In authors case, as system is powered from central power supply for testing purpose, measurements can be taken more frequently than it is needed. In authors case measurements are performed each 60 seconds.

In the future it is planned to use battery power also for the networking part for the real system deployment. It was evaluated that individual measurement node's current draw (at 3.3V) during different operational modes are as follows:

- Measurement mode (device is making measurements and getting values from connected sensors): 25mA for 1.2s
- WiFi power-up mode (device is switching on the Wi-Fi module): 47mA for 1.4s
- Connection mode (device is connecting to the Wi-Fi network and getting network configuration parameters): 69mA for 2.3s
- Data sending mode (device sends measurement data): 79 mA for 1.8s
- Going into sleep mode (switching off the modules): 36 mA for 1.4s
- Sleep mode (there is no activity of the device, it is in deep sleep state): 0,028 mA for 60s

Current consumption was logged using the UNI-T UT181A True RMS Datalogging Multimeter. Current draw by different operational states is represented below:

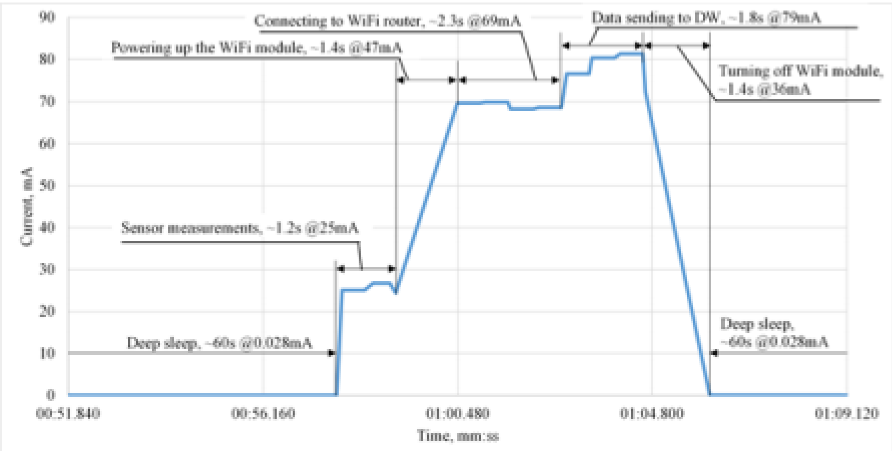

Fig. 2. Current draw during one measurement iteration (at 3.3V)

The battery life is depending on the measurement intervals. If the system will perform measurements each two minutes and will use four 1900mAh batteries, then theoretically system can operate for 18 days. Authors also developed Web based calculator for estimation of battery life, see https://sams.science.itf.llu.lv/battery-life (Fig. 3).

Measurement intervals are directly connected with events beekeeper would like to detect and bee colony states that should be identified. Some bee colony states require constant and frequent (each 1 min) measurements, but for some states several measurements per day is enough. Table 2 summarises possible bee colony states and needed measurement and intervals (recommended and minimally required), which can be detected based on weight and / or temperature measurements.

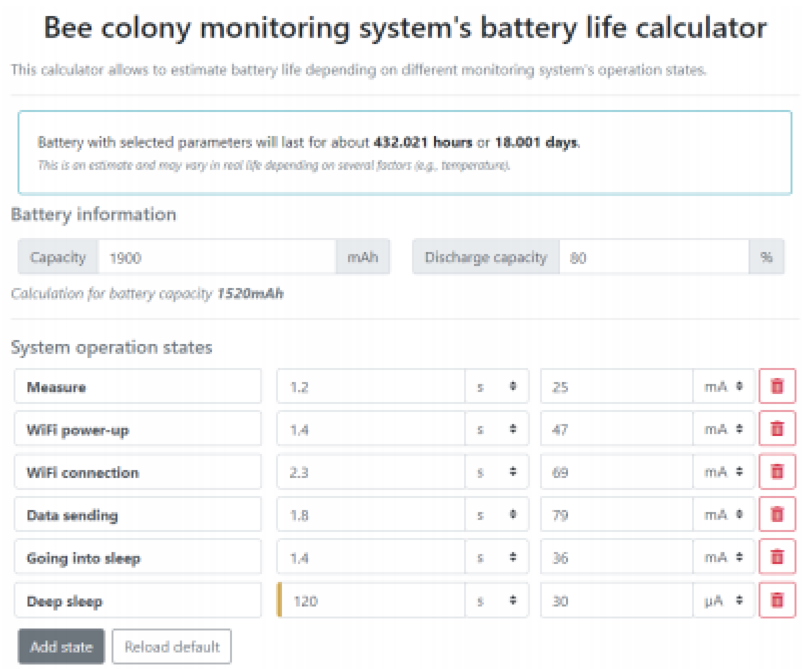

Fig. 3. Screenshot of the developed Web calculator

Table 2. Summary of possible bee colony states and their detection

Event or state of the colony	Parameter	Recommended interval	Required interval
Start of the mass nectar flow	Weight	Each 4 hours	1 per day
End of nectar flow	Weight	Each 4 hours	1 per day
Swarming	Temperature	Each 1 min	Each 5 min
	Weight	Each 30 min	Each 1 hour
Broodless	Temperature*	Each 30 min	Each 1 hour
Absconding	Temperature*	Each 1 hour	1 per day
	Weight	Each 1 hour	Each 4 hours
CCD	Temperature*	Each 1 hour	1 per day
	Weight	Each 1 hour	Each 4 hours
Death	Temperature*	Each 1 hour	1 per day

* ambient temperature is also needed

As well it should be mentioned that for precise weight measurements single point load cell should be calibrated before placing the beehive on it.

Developed PCB prototype of the authors' system is shown below:

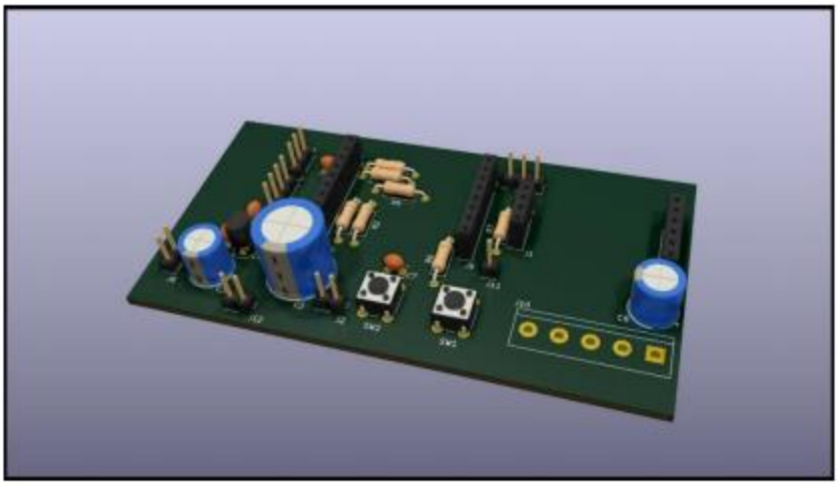

Fig. 4. 3D PCB prototype of the developed monitoring system's measurement node

3. Developed digital system for bee colony monitoring

Next important aspect of the whole system after the hardware development, is implementation of the data transfer procedures and methods. For the data storage and reporting specific SAMS data warehouse (DW) is developed. DW is available online at https://sams.science.itf.llu.lv/. SAMS DW is a universal system, which is able to operate with different data inputs and have flexible data processing algorithms. SAMS DW solution uses authentication and authorization services provided by Auth0 universal platform (https://auth0.com/). There are several steps, that have to be performed on device to send data to the remote data warehouse:

1. Acquire access token. Access token is used by DW to authenticate and authorize the request. In order to acquire the token, the device should send POST request to https://sams.science.itf.llu.lv/api/token with its Client ID and secret (requested individually). Each device has its unique credentials.
2. Post the data to DW. There is a single endpoint for posting data to DW – https://sams.science.itf.llu.lv/api/data. Access token should be provided in the Authorization header and request body can contain multiple data packages.
3. Reports about posted measurements are immediately available in UI under the Reports section. Additional debugging information is available in Dashboard and Devices (last events and errors).

Full instruction on how to connect general bee colony monitoring hardware to the SAMS data warehouse is available online:

https://sams-project.eu/wp-content/uploads/2020/02/DW-data-sending-guide.pdf

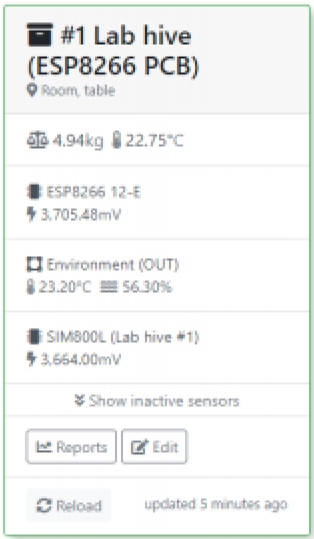

Fig. 5. SAMS data warehouse Dashboard colony card with sensor data

4. Conclusions

Continuous, remote and real time monitoring of the bee colony weight and temperature becomes a must have procedure in the beekeeping practice and acts as a first stage in implementation of the Precision Beekeeping approach.

Weight monitoring of at least one reference colony at the apiary can help to identify start and end of the nectar flow and evaluate the colony foraging activity.

Developed monitoring system focuses on minimisation of manual bee colony inspections, which should lead to the minimisation of stress to the bee colony and increase of welfare.

Proposed honey bee monitoring system uses one single point load cell for weight measurements, one temperature sensor for internal colony temperature and ESP8266 for data collection from the sensors and transferring it to the remote data warehouse. In a future system can be set up also in a remote area, when alternative power supply and mobile network capabilities will be integrated.

Developed web tool for monitoring system power consumption and battery life estimation can help to evaluate developed system sustainability and applicability and provide useful information for potential solar powered solution.

There are many possible bee colony states therefore it is crucial to choose the right measurement intervals for correct state detection.

Application of ICT solutions and remote monitoring systems facilitates the beekeepers' knowledge gathering about behaviour of individual bee colonies and improve the efficiency of beekeeping management.

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References

Bradbear, N. (2009). "Bees and their role in forest livelihoods" A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. Food and Agricultural Organization of the United Nations, 19, 194. https://doi.org/10.1017/CBO9781107415324.004

Breeze, T. D., Bailey, A. P., Balcombe, K. G., Potts, S. G. (2011). Pollination services in the UK: How important are honeybees? Agriculture, Ecosystems Environment, 142(3–4), 137–143. https://doi.org/10.1016/j.agee.2011.03.020

Buchmann, S., Thoenes, S. (1990). The electronic scale honey bee colony as a management and research tool. Bee Science, 1, 40–47. Retrieved from http://www.cabdirect.org/abstracts/19910229804.html

Fitzgerald, D. W., Edwards-Murphy, F., Wright, W. M. D., Whelan, P. M., Popovici, E. M. (2015). Design and development of a smart weighing scale for beehive monitoring. 26th Irish Signals and Systems Conference, ISSC 2015, 1–6. https://doi.org/10.1109/ISSC.2015.7163763

Komasilovs, V., Zacepins, A., Kviesis, A., Fiedler, S., Kirchner, S. (2019). Modular sensory hardware and data processing solution for implementation of the precision beekeeping. Agronomy Research, 17(2), 509–517. https://doi.org/10.15159/AR.19.038

Kviesis, A, Zacepins, A. (2015). System Architectures for Real-time Bee Colony Temperature Monitoring. Procedia Computer Science, 43, 86–94. https://doi.org/DOI: 10.1016/j.procs.2014.12.012

Kviesis, A., Komasilovs, V., Komasilova, O., Zacepins, A. (2020). Application of fuzzy logic for honey bee colony state detection based on temperature data. Biosystems Engineering, 193, 90–100. https://doi.org/10.1016/j.biosystemseng.2020.02.010

Lecocq, A., Kryger, P., Vejsnæs, F., Bruun Jensen, A. (2015). Weight Watching and the Effect of Landscape on Honeybee Colony Productivity: Investigating the Value of Colony Weight Monitoring for the Beekeeping Industry. PLOS ONE, 10(7), e0132473. https://doi.org/10.1371/journal.pone.0132473

Meikle, W. G., Holst, N. (2015). Application of continuous monitoring of honeybee colonies. Apidologie, 46(1), 10–22. https://doi.org/10.1007/s13592-014-0298-x

Meikle, W., Hoist, N., Mercadier, G. (2006). Using balances linked to dataloggers to monitor honey bee colonies. Journal of Apicultural Research, 45, 39–41. Retrieved from http://cat.inist.fr/?aModele=afficheN&cpsidt=17873767

Meikle, W., Rector, B., Mercadier, G., Holst, N. (2008). Within-day variation in continuous hive weight data as a measure of honey bee colony activity. Apidologie, (39), 694–707. Retrieved from http://link.springer.com/article/10.1051/apido:2008055

Ochoa, I. Z., Gutierrez, S., Rodriguez, F. (2019). Internet of Things: Low Cost Monitoring BeeHive System using Wireless Sensor Network. 2019 IEEE International Conference on Engineering Veracruz (ICEV), 1–7. https://doi.org/10.1109/ICEV.2019.8920622

Odoux, J.-F., Aupinel, P., Gateff, S., Requier, F., Henry, M., Bretagnolle, V. (2014). ECOBEE: a tool for long-term honey bee colony monitoring at the landscape scale in West European intensive agroecosystems. Journal of Apicultural Research, 53(1), 57–66. https://doi.org/10.3896/IBRA.1.53.1.05

Simon-Delso, N., San Martin, G., Bruneau, E., Minsart, L.-A., Mouret, C., Hautier, L. (2014). Honeybee Colony Disorder in Crop Areas: The Role of Pesticides and Viruses. PLoS ONE, 9(7), e103073. https://doi.org/10.1371/journal.pone.0103073

Southwick, E. E. (1992). Physiology and social physiology of the honey bee. In The Hive and the Honey Bee, (pp. 171–196). Retrieved from http://scholar.google.com/scholar?hl=enbtnG=Searchq=intitle:Physiology+and+social+physiology+of+the+honey+bee#1

Terenzi, A., Cecchi, S., Spinsante, S., Orcioni, S., Piazza, F. (2019). Real-time System Implementation for Bee Hives Weight Measurement. 2019 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor), 231–236. https://doi.org/10.1109/MetroAgriFor.2019.8909252

Zabasta, A., Zhiravetska, A., Kunicina, N., Kondratjevs, K. (2019). Technical Implementation of IoT Concept for Bee Colony Monitoring. In 2019 8th Mediterranean Conference on Embedded Computing (MECO), 1–4. https://doi.org/10.1109/meco.2019.8760180

Zacepins, A., Pecka, A., Osadcuks, V., Kviesis, A., Engel, S. (2017). Solution for automated bee colony weight monitoring. Agronomy Research, 15(2), 585–593.

Zacepins, A., Stals, M., Kviesis, A., Komasilovs, V., Komasilova, O. (2020). Evaluation of the economic gains of the bee colony remote monitoring. Agronomy Research, Submitted.

Zacepins, A, Jelinskis, J., Kviesis, A., Dzenis, M., Komasilovs, V., Komasilova, O. (2018). Application of LoRaWAN technology in Precision Beekeeping. IX International Scientific Agriculture Symposium "AGROSYM 2018", Jahorina, Bosnia and Herzegovina, 4-7 October 2018. Book of Proceedings, pp. 1759–1765.

Zacepins, A, Karasha, T. (2013). Application of temperature measurements for the bee colony monitoring : a review. Proceedings of the 12th International Scientific Conference "Engineering for Rural Development," 126–131. Jelgava, Latvia.

Zacepins, A., Brusbardis, V., Meitalovs, J., Stalidzans, E. (2015). Challenges in the development of Precision Beekeeping. Biosystems Engineering, 130, 60–71. https://doi.org/10.1016/j.biosystemseng.2014.12.001

Zgank, A. (2019). Bee Swarm Activity Acoustic Classification for an IoT-Based Farm Service. Sensors, 20(1), 21. https://doi.org/10.3390/s20010021

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AUTOMATED SYSTEM FOR BEE COLONY WEIGHT MONITORING

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ABSTRACT

Real time, continuous and remote monitoring of the honeybee colonies with application of information and communication technologies (ICT) is becoming increasingly frequent in industry and in a scientific research. Combination of ICT and beekeeping led to the development of the Precision Beekeeping approach. Successful implementation of the Precision Beekeeping system includes development of the bee colony monitoring hardware solution and computer software for data collection and further analysis. This paper describes developed and implemented bee colony monitoring unit for weight and temperature monitoring. Bee colony weight is one of the key metrics of the strength of a colony. Changes in weight can reflect the productivity rate of the colony, as well as its health and state. Developed monitoring system is based on Raspberry Pi Zero W single board computer with several connected sensors for bee colony temperature and environmental parameter monitoring. Weight is measured using single point load cell with possibility to measure weight up to 200kg, which is enough for the beehive measurements. Data transfer from the remote bee colony is provided by the external 3G router. For data storage and analysis cloud-based data warehouse is developed. Collected data is accessible in the web system with user friendly interface for data visualisation and reporting. Within this research scale calibration process is described and accuracy of the weighting is evaluated and possible challenges are discussed. Described monitoring system is developed within the Horizon 2020 project SAMS, which is funded by the European Union within the H2020-ICT-39-2016-2017 call. To find out more visit the project website https://sams-project.eu/.

Keywords: *Precision Beekeeping, Precision Apiculture, weight monitoring, bee colony monitoring, SAMS project.*

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INTRODUCTION

Insects are the main pollinators for agricultural and horticultural plants (Kremen, Williams, & Thorp, 2002; Partap, 2011). Up to 79% of the human food supply today is dependent on pollination, and the honey bee is the most widespread and active pollinator animal worldwide (Bradbear, 2009; Breeze, Bailey, Balcombe, & Potts, 2011). Besides the important aspect of pollination, honey bees also produce a variety of valuable bee products like honey, beeswax, pollen and etc. which also leads to an economic benefit for the beekeeper (Crane, 1990). Recently Precision Beekeeping (Precision Apiculture) has been defined, as apiary management strategy based on individual bee colony monitoring (Aleksejs Zacepins, Brusbardis, Meitalovs, & Stalidzans, 2015). Within the Precision Beekeeping hardware and software solutions should be developed and implemented to assist the beekeeper by providing real-time data and decisions about the bee colonies and their states. The monitoring of honeybee colonies over long periods of time can result in long-term data for better analysis and understanding of the colony behaviour (Lecocq, Kryger, Vejsnæs, & Jensen, 2015; Odoux et al., 2014; Simon-Delso et al., 2014).

Behaviour and state of bee colonies can be monitored by use of temperature, humidity, acoustic, video, weight and other sensors (W. G. Meikle & Holst, 2015). Continuous monitoring of those parameters is becoming feasible for most beekeepers as the cost and size of the end devices decrease while their precision and capacity increase. Additional benefit of the remote monitoring of colonies is in minimising the number of local manual colony inspections as frequent, physical inspections of bee colonies interferes bees and can cause additional stress, that negatively affects the whole colony productivity (Komasilovs, Zacepins, Kviesis, Fiedler, & Kirchner, 2019; Zabasta, Zhiravetska, Kunicina, & Kondratjevs, 2019). As well implementation of the bee colony monitoring solutions provides economical benefit for the beekeepers, taking into account that every inspection of the remote apiary adds additional transportation costs to the beekeepers (W. G. Meikle & Holst, 2015; Zetterman, 2018).

Bee hive weight provides one of the most important kinds of data beekeeper can have about the colonies (Fitzgerald, Edwards-Murphy, Wright, Whelan, & Popovici, 2015). Automated weight systems can supply the beekeeper with important information on several important events from the honey bee colonies (Buchmann & Thoenes, 1990; McLellan, 1977; W. Meikle, Hoist, & Mercadier, 2006). Weight is related to such important activities of the bee colony like starting of nectar collection, resource consumption by the colony indicating the need of additional feeding. Weight data shows the beekeepers when to add supers or start a honey harvesting. Commercial beekeepers can use beehive scales to save unnecessary visits to the apiary when they do long-distance migration (Human & Brodschneider, 2013).

Idea of weighing of the bee colonies is not new, since the 1950s it is suggested to use weight as an indication of health and productivity (McLellan, 1977), and today there are a big number of ready commercial and homemade solutions for this purpose available for the beekeepers (Human & Brodschneider, 2013). One major difference among different vendors and systems is the number of load cells in the product, which may be one, two, or four, but any of these arrangements will work. https://colonymonitoring.com/current-sensors/ summarised many vendors and their products in one place. Besides the commercial products many handmade systems are available too. As well some scientifically used solutions are described in many publications (Cecchi et al., 2019; Fitzgerald et al., 2015; Gil-Lebrero et al., 2016; Ochoa, Gutierrez, & Rodriguez, 2019; Sengul Dogan, Erhan Akbal, 2017; Terenzi, Cecchi, Spinsante, Orcioni, & Piazza, 2019; Zabasta et al., 2019; A. Zacepins, Pecka, Osadcuks, Kviesis, & Engel, 2017).

Additional value of the bee colony monitoring is an option to geographically distribute and install of automated electronic scales (Lecocq et al., 2015), then share the collected data with other beekeepers to inform about the start of the nectar flow in different geographical regions. There are several such initiatives found in the web (list is not full and there are many more such systems):

- http://honeybeenet.gsfc.nasa.gov – the NASA Goddard Space Flight Centre has initiated a project in which the daily weighing of hives by volunteer beekeepers are merged with satellite data (Nightingale, Esaias, Wolfe, Nickeson, & Ma, 2008).
- https://www.beeandmegmbh.com/global-map-bee-hives - some of the beehive worldwide made public by the BeeAndme for scientific, collaborative or information purposes.
- http://mybees.buzz/ – this Web system shows data about main bee colony parameter changes from different Nordic countries, including Denmark, Sweden, Norway, Latvia and Estonia. System is developed by the Danish Beekeepers Association.
- svari.strops.lv – this Web systems shows data from several bee colonies located in Latvia using the Capaz monitoring system. System is developed by the Latvian Beekeeping Association.

The aim of this paper is to describe the developed honey bee colony weight monitoring system for weight and temperature measurements using one load cell, as load cells become a standard in bee colony weighing systems and Raspberry Pi Zero (Arduino, ESP?) computer.

Development of the bee colony weigh monitoring system is done within the Horizon 2020 project SAMS. A combined biological, sociological and technical approach is made within the SAMS - Smart Apiculture Management Services - project (https://sams-project.eu/).

DEVELOPED SYSTEM FOR WEIGHT AND TEMPERATURE MONITORING

Inapplicability for outdoor conditions of continuously loaded general purpose electronic scales and sometimes the high costs of the available commercial solutions limits their application in Precision Beekeeping. Manual weighing of the colonies is possible, but too laborious to perform frequently and also procedure of lifting the hive and putting on the scales makes addition disturbance to the bee colony (Stalidzans et al., 2017). So still there is an open possibilities and open market for development of affordable and reliable solution for the automated bee colony weighting.

Authors of this research developed prototype of honeybee colony weight monitoring system based on single point load cell (BOSCHE Wagetechnik Single point load cell H30A, https://www.bosche.eu/en/scale-components/load-cells/single-point-load-cell/single-point-load-cell-h30a) with max load of 200kg and Raspberry Pi Zero W single board computer. In addition, two sensors are added to the system for bee colony temperature and environmental humidity and temperature monitoring. For getting the weight data analogue/digital converter HX711 is used. At this stage system is powered by standard 220V power supply, but in the future, it is planned to implement power management from renewable energy sources (e.g. solar power) and additional battery for energy storage. As well for data sending to the remote server wi-fi network (provided by the 3G router) is used, but it can be easily substituted by mobile network adding additional module to the Raspberry Pi directly or even using modern data transfer technologies, like LoRaWAN (A Zacepins et al., 2018) or other. At this moment system is assembled using the breadboard, but after testing separate printed circuit board with casing will be designed and manufactured. Developed system's architecture is based on proposed approach by (Kviesis & Zacepins, 2015) where individual measurement node sends monitoring data to the remote server via wireless or mobile network.

Load cell is mounted between two metal plates (10cm x 15cm), and then metal plates are screwed to the plywood plates (50cm x 50cm) as described in the load cell manual. Beehive can be placed directly on the platform or some additional wooden planks can be used. Mounting of the load cell is shown in Figure 1.

Economic aspect is very crucial for the beekeepers, therefore system costs should be as minimal as possible. In authors case costs for system components and additional materials are summarised in Table 1.

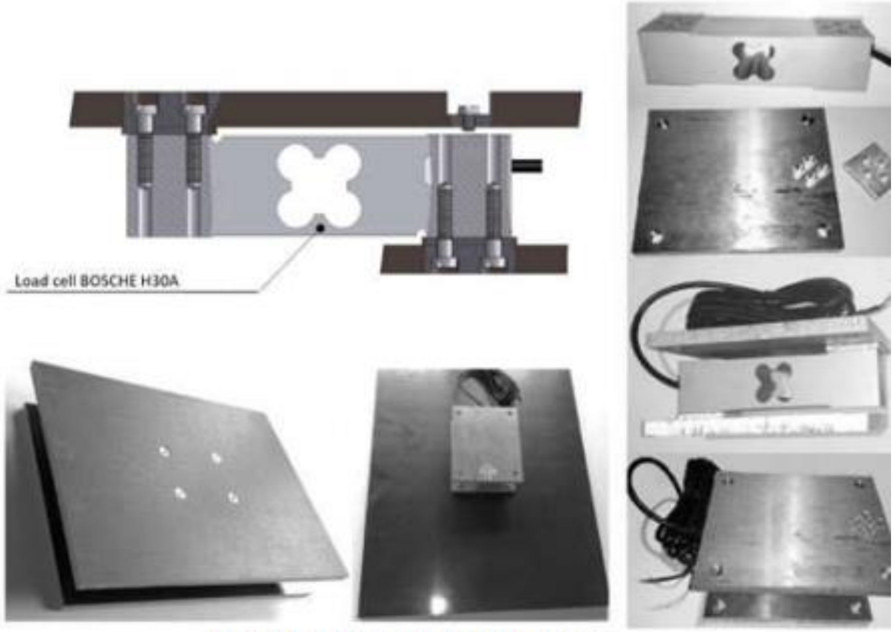

Figure 1. Load cell assembling process

Table 1. System components with unit costs

Nr.	Name of the component	Cost (in EUR)
1	BOSCHE Wagetechnik Single point load cell H30A (200kg)	50.00
2	Platform for load cell	50.00
2.1	Plywood	*14.00*
2.2	Metal plate	*14.00*
2.3	Screws	*2.00*
2.4	Assembling costs	*20.00*
3	Raspberry Pi Zero W + SD card	22.00
4	Temperature sensor DS18B20	4.00
5	Humidity and temperature sensor DHT22	7.00
6	A/D converter Sparkfun HX711	11.00
7	3G router Huawei E5330	37.00
8	Additional components (breadboard, wires, connectors, etc.)	10.00

The costs for one developed system are 191.00 EUR. System installation, maintenance, data storage, SIM card with appropriate data plan and usage of the web system is not taken into account in those calculations. As well some

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components are optional, like 3G router can be dismissed if there are Wi-Fi connection at the site.

Measurement intervals can be configured individually based on required information that should be gained from the system. In authors case, as system is powered from central power network measurement can happen more frequently that it would be needed in real situation. In authors case measurements are performed each 2 minutes.

Sensitivity tolerance of the chosen load cell is ±0.2 mV/V, which gives measurement error of ±1 g, nevertheless calibration with standard weight is necessary. This resolution is more than enough for the beekeepers, because during the active summer period hive weight changes can achieve 1-3 kg during the day.

LOAD CELL CALIBRATION PROCESS

For precise weight measurements load cell should be calibrated before placing the beehive on it. Calibration technically means to determine the difference between the scale readout and the actual weight on the weighing platform to determine accuracy. Calibration was performed placing an object with known weight on a scales, making several weightings and getting the needed offset and scale factor values.

For scales precision evaluation weighting experiment with known weights (5kg, 7.853 kg, 10kg, 17,853kg metal weight) using three physical weights of 5kg, 5kg and 7.853kg was performed in the laboratory. Ten measurements each two minutes was performed. Weights were placed at the centre of the scale platform. Overview of the test measurements are summarised in Table 2 below:

Table 2. Overview of the test weighing measurements

Id of the experiment	Known weight (g)	Average (from 10 readings) reading from the scales (g)	Error (g)	STDEV (g)	Error (%)
EXP-1	0	4,5	4,5	1,51	-
EXP-1	5000	5001,9	1,9	0,99	0,038
EXP-1	7853	7856	3	0,94	0,038
EXP-1	10000	10001	1	1,15	0,010
EXP-1	17853	17857,5	4,5	1,18	0,025

One of the possible problems with scales precision when using single point load cell could be when object is placed not in the centre but in some corner of the platform. To evaluate this, additional experiments are performed placing weights at different locations on the scale platform and making once again ten measurements each two minutes. Overview of the test measurements are summarised in Table 3 below:

Table 3. Overview of the test weighing measurements placing weights at different locations

Id of the experiment	Known weight (g)	Average (from 10 readings) reading from the scales (g)	Error (g)	STDEV (g)	Error (%)
EXP-2	17853	17848,9	-4,1	1,10	-0,023
EXP-3	17853	17864,4	11,4	0,84	0,064
EXP-4	17853	17877,1	24,1	1,52	0,135
EXP-5	17853	17858,1	5,1	1,45	0,029
EXP-6	17853	17855,9	2,9	0,88	0,016

Experiment set-up and location of weights is shown in Figure 2 below:

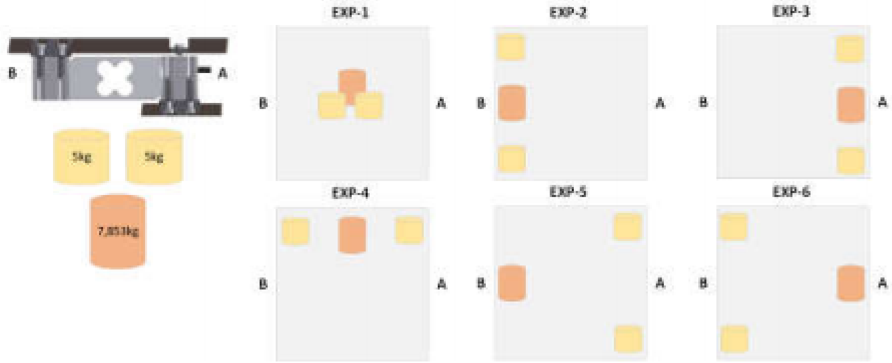

Figure 2. Location of weight on a scale platform during the weighting experiment

Analysing the measurements, it can be seen that there are minor changes in values depending on the placement of weight on a scale platform, but those can be considered as insignificant, as error is less than 1 %.

During the experiments it is found that any physical operation with scales, like lifting, changing its location affects the weighting values. Therefore, it needed to perform taring procedure each time scales are transported to a new location. For the beekeepers it is mean additional operation to perform before initial bee hive weighting. To make this process more user-friendly authors developed a physical interface for scale taring operation. Basically, additional button is connected to the system and when it is pressed system make taring operation.

Another issue found during lab experiments is weight fluctuation in relation to environmental temperature. With increase of the temperature weight is decreasing (see Fig. 3). Authors made a conclusion that A/D converter is affected by the temperature changes. It is confirmed by heating the A/D converter by the electric heater and monitoring the weight change.

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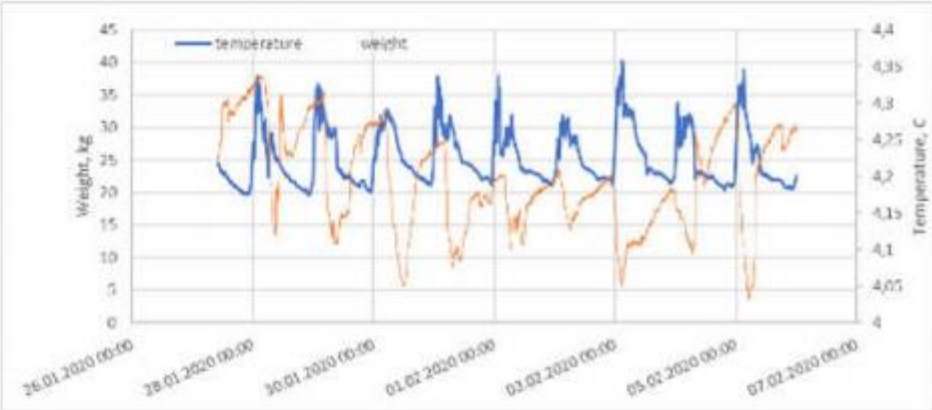

Figure 3. Relation of the weight measurements with environmental temperature

FIELD TESTS WITH DEVELOPED SYSTEM

After calibration, tests and experiments in laboratory system was installed in real environment to monitor two bee colonies during the passive wintering period. Practical experiments were conducted in the bee colony wintering building made from metal sandwich panels (Stalidzans et al., 2017) in the LLU apiary in Strazdu iela, Jelgava, Latvia. Colonies were placed in the wintering building on 21.01.2020. Figure 4 below demonstrates real placement of the developed system:

Figure 4. Installation of the system in real environment

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For the measurement storage and analysis data management solution was developed. Authors called it data warehouse (DW). DW is developed with main aim to help beekeepers run the apiary more effectively by utilising higher amount of available data and accumulated data interpretation knowledge. DW architecture is developed considering flexibility and extensibility. Within the DW data visualisation is possible. Figure 5. below demonstrates chart with weight dynamic of the bee colonies:

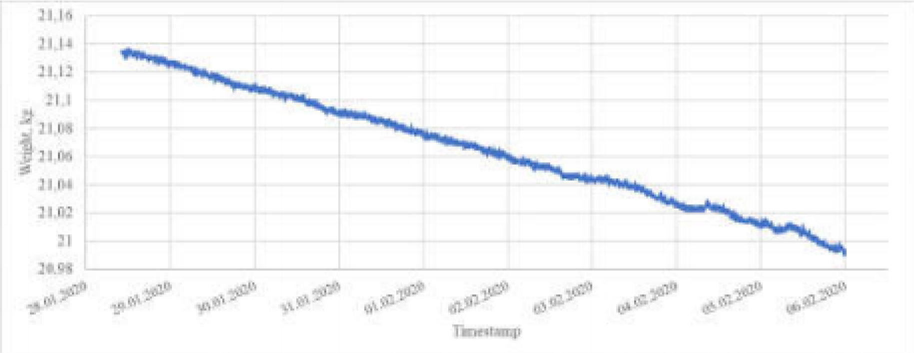

Figure 5. Weight dynamic of one bee colony

CONCLUSIONS

Continuous and real time monitoring of the bee colony main parameters like weight and temperature becomes a standard procedure in the beekeeping practice and acts as a first stage in implementation of the Precision Beekeeping approach.
Weight monitoring of at least one reference colony at the apiary can help to identify periods of the nectar flow and predict the colony foraging activity.
Developed system should be used to minimise the number of manual bee colony inspections, which should lead to the minimisation of stress to the bee colony.
Proposed honey bee weight and temperature monitoring system uses one load cell for weight measurements, very accurate (± 0.4 °C) two temperature sensors and Raspberry Pi for data collection from the sensors and transferring it to the remote data warehouse. In a future system can be set up also in a remote area, when alternative power supply and mobile network capabilities will be integrated.
Developed system could also be extended with additional functionality adding new sensors for example for detection of hive openings, or detection of other disturbances (e.g, hives can be damaged by animals).

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REFERENCES

Bradbear, N. (2009). "Bees and their role in forest livelihoods" A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. *Food and Agricultural Organization of the United Nations*, *19*, 194. https://doi.org/10.1017/CBO9781107415324.004

Breeze, T. D., Bailey, A. P., Balcombe, K. G., & Potts, S. G. (2011). Pollination services in the UK: How important are honeybees? *Agriculture, Ecosystems & Environment*, *142*(3–4), 137–143. https://doi.org/10.1016/j.agee.2011.03.020

Buchmann, S., & Thoenes, S. (1990). The electronic scale honey bee colony as a management and research tool. *Bee Science*, *1*, 40–47. Retrieved from http://www.cabdirect.org/abstracts/19910229804.html

Cecchi, S., Terenzi, A., Orcioni, S., Spinsante, S., Mariani Primiani, V., Moglie, F., Isidoro, N. (2019). Multi-sensor platform for real time measurements of honey bee hive parameters. *IOP Conference Series: Earth and Environmental Science*, *275*, 012016. https://doi.org/10.1088/1755-1315/275/1/012016

Crane, E. (1990). *Bees and beekeeping: science, practice and world resources*. Heinemann Newnes.

Fitzgerald, D. W., Edwards-Murphy, F., Wright, W. M. D., Whelan, P. M., & Popovici, E. M. (2015). Design and development of a smart weighing scale for beehive monitoring. *2015 26th Irish Signals and Systems Conference, ISSC 2015*, 1–6. https://doi.org/10.1109/ISSC.2015.7163763

Gil-Lebrero, S., Quiles-Latorre, F., Ortiz-López, M., Sánchez-Ruiz, V., Gámiz-López, V., & Luna-Rodríguez, J. (2016). Honey Bee Colonies Remote Monitoring System. *Sensors*, *17*(12), 55. https://doi.org/10.3390/s17010055

Human, H., & Brodschneider, R. (2013). Miscellaneous standard methods for Apis mellifera research. *Apicultural Research*, *52*(4), 1–53.

Komasilovs, V., Zacepins, A., Kviesis, A., Fiedler, S., & Kirchner, S. (2019). Modular sensory hardware and data processing solution for implementation of the precision beekeeping. *Agronomy Research*, *17*(2), 509–517. https://doi.org/10.15159/AR.19.038

Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(26), 16812–16816. https://doi.org/10.1073/pnas.262413599

Kviesis, A., & Zacepins, A. (2015). System Architectures for Real-time Bee Colony Temperature Monitoring. *Procedia Computer Science*, *43*, 86–94. https://doi.org/DOI: 10.1016/j.procs.2014.12.012

Lecocq, A., Kryger, P., Vejsnæs, F., & Jensen, A. B. (2015). Weight watching and the effect of landscape on honeybee colony productivity: Investigating the value of colony weight monitoring for the beekeeping industry. *PLoS ONE*, *10*(7). https://doi.org/10.1371/journal.pone.0132473

McLellan, A. (1977). Honeybee colony weight as an index of honey production and nectar flow: a critical evaluation. *Journal of Applied Ecology*, *14*, 401–408. Retrieved from http://www.jstor.org/stable/2402553

Meikle, W. G., & Holst, N. (2015). Application of continuous monitoring of honeybee colonies. *Apidologie*, *46*(1), 10–22. https://doi.org/10.1007/s13592-014-0298-x

Meikle, W., Hoist, N., & Mercadier, G. (2006). Using balances linked to dataloggers to monitor honey bee colonies. *Journal of Apicultural Research*, *45*, 39–41. Retrieved from http://cat.inist.fr/?aModele=afficheN&cpsidt=17873767

Nightingale, J. M., Esaias, W. E., Wolfe, R. E., Nickeson, J. E., & Ma, P. L. A. (2008). Assessing Honey Bee Equilibrium Range and Forage Supply using Satelite-Derived Phenology. *IGARSS 2008 - 2008 IEEE International Geoscience and Remote Sensing Symposium*, III-763-III–766. https://doi.org/10.1109/IGARSS.2008.4779460

Ochoa, I. Z., Gutierrez, S., & Rodriguez, F. (2019). Internet of Things: Low Cost Monitoring BeeHive System using Wireless Sensor Network. *2019 IEEE International Conference on Engineering Veracruz (ICEV)*, 1–7. https://doi.org/10.1109/ICEV.2019.8920622

Odoux, J.-F., Aupinel, P., Gateff, S., Requier, F., Henry, M., & Bretagnolle, V. (2014). ECOBEE: a tool for long-term honey bee colony monitoring at the landscape scale in West European intensive agroecosystems. *Journal of Apicultural Research*, *53*(1), 57–66. https://doi.org/10.3896/IBRA.1.53.1.05

Partap, U. (2011). The pollination role of honey bees. In *Honey bees of Asia* (pp. 227–255). Berlin: Springer.

Sengul Dogan, Erhan Akbal, G. ozmen koca. (2017). Design of a Remote Controlled Beehive for Improving Efficiency of Beekeeping Activities. *8th International Advanced Technolohies Symposium*, (November), 1084–1090.

Simon-Delso, N., San Martin, G., Bruneau, E., Minsart, L.-A., Mouret, C., & Hautier, L. (2014). Honeybee Colony Disorder in Crop Areas: The Role of Pesticides and Viruses. *PLoS ONE*, *9*(7), e103073. https://doi.org/10.1371/journal.pone.0103073

Stalidzans, E., Zacepins, A., Kviesis, A., Brusbardis, V., Meitalovs, J., Paura, L., … Liepniece, M. (2017). Dynamics of Weight Change and Temperature of Apis mellifera (Hymenoptera: Apidae) Colonies in a Wintering Building With Controlled Temperature. *Journal of Economic Entomology*, tow282. https://doi.org/10.1093/jee/tow282

Terenzi, A., Cecchi, S., Spinsante, S., Orcioni, S., & Piazza, F. (2019). Real-time System Implementation for Bee Hives Weight Measurement. *2019 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)*, 231–236. https://doi.org/10.1109/MetroAgriFor.2019.8909252

Zabasta, A., Zhiravetska, A., Kunicina, N., & Kondratjevs, K. (2019). Technical Implementation of IoT Concept for Bee Colony Monitoring. *In 2019 8th Mediterranean Conference on Embedded Computing (MECO)*, 1–4. https://doi.org/10.1109/meco.2019.8760180

Zacepins, A., Pecka, A., Osadcuks, V., Kviesis, A., & Engel, S. (2017). Solution for automated bee colony weight monitoring. *Agronomy Research*, *15*(2), 585–593.

Zacepins, A, Jelinskis, J., Kviesis, A., Dzenis, M., Komasilovs, V., & Komasilova, O. (2018). Application of LoRaWAN technology in Precision Beekeeping. *IX International Scientific Agriculture Symposium "AGROSYM 2018", Jahorina, Bosnia and Herzegovina, 4-7 October 2018. Book of Proceedings*, pp. 1759–1765.

Zacepins, Aleksejs, Brusbardis, V., Meitalovs, J., & Stalidzans, E. (2015). Challenges in the development of Precision Beekeeping. *Biosystems Engineering*, *130*, 60–71. https://doi.org/10.1016/j.biosystemseng.2014.12.001

Zetterman, B. E. A. (2018). *Beekeepers usage of IoT*. Data collection, sharing and visualization in the domain of beekeeping. Master Thesis, Linnaeus University, 64p.

2.12 October 2020 – Evaluation of the economic gains of the bee colony remote monitoring

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EVALUATION OF THE ECONOMIC GAINS OF THE BEE COLONY REMOTE MONITORING

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Abstract

Precision Beekeeping is focusing on individual bee colony remote monitoring using different measurement systems and sensors. One task of the Precision Beekeeping is to continuously collect real-time data about bee colonies for its further analysis with aim to identify different states and abnormal behaviour. In many cases bee colonies have many different parameters available for constant monitoring and the beekeeper should decide what kind of IT system is needed to accomplish this task. Automatic monitoring systems offer many advantages for the beekeepers, but also have their installation price and maintenance costs, so the economic aspect of the IT system implementation should be considered when implementing monitoring system within the Precision Beekeeping. This paper describes possible economic gains while such systems are implemented. Different scenarios are observed and discussed. Return of investment coefficient is calculated as well to find out how fast investments for system implementation of the specific monitoring system will be returned. In addition, to ease the process of calculation of all formulas and evaluate the economic gains of the implementation of bee colony remote monitoring system, online web tool (application) is developed and published for public use. Based on made calculations and assumptions it can be concluded that beekeepers need adjustable bee colony monitoring system for cheap basic measurements of all colonies and one main module for in-deep monitoring of referenced colony within one remote apiary.

Keywords: *Precision Beekeeping, Precision Apiculture, economics of beekeeping, return of investments, SAMS project.*

Introduction

Beekeeping is traditional and very old branch of agriculture with significant impact on other agricultural sectors, as honey bees are the main insect pollinators. Up to 75% of the crops, used for human feeding depends on pollination (Ollerton et al, 2011; Potts et al, 2016). Bees plays the important role in whole crop production chain and survival of wild plant species (Gallai et al., 2008; Klein et al., 2007). Over the last 60 years dependence on bees for pollination increased to about 300% (Aizen & Harder, 2009). Health status and decrease of the honey bee population worldwide is a growing concern amongst scientists, ecologists, environment specialists, farmers and also a policy makers. It is concluded, that bees are the most impacted species by the anthropogenic factors (application of agri-chemicals, environmental pollution, changes in land use patterns, Colony Collapse Disorder, etc.) around the planet with serious long-term consequences for agriculture and forestry (Kaplan, 2008). A significant decrease of honey bee colonies can affect the whole agricultural production chain.
In a traditional approach, to evaluate the status of the bee colony, beekeepers have to make frequent visual observation of the bee colony, by opening the hive. Often intrusive bee colony inspections are time consuming, can lead to a stress of the colony (Zacepins et al., 2016) also

remote monitoring reduces beekeeper's spending on unneeded travelling to remote apiary (Komasilovs et al., 2019). Rapid development of the sensing, data transmission, microprocessor technologies allowed the development of the automatic remote bee colony monitoring systems which can assist beekeepers with adding important information on the bee behaviour and possible state without an invasive inspection (Bromenshenk et al., 2015; Human & Brodschneider, 2013; Kridi et al., 2014; Kridi, et al., 2016; Meikle & Holst, 2015; Sánchez et al., 2015; Zogovic et al., 2017).

Future of the traditional beekeeping is to implement smart apiary management approach and start to use automatic and remote tools for bee colony monitoring together with beehive control mechanisms to improve the bee colony productivity. Implementation of technological inventions for the bee colony monitoring lead to the Precision Beekeeping or Precision Apiculture foundation. Precision beekeeping is defined as an apiary management strategy based on the monitoring of individual bee colonies to minimise resource consumption and maximise the productivity of bees (Zacepins et al., 2015). The main idea of the precision beekeeping is to observe each hive individually and make inspections, treatment, management actions only to individual hives, thus minimising the time needed for manual inspections of all colonies and minimising the disturbance of bee colonies. There are many positive aspects of the bee colony remote monitoring with regards of non-disturbance of bee hives, decreasing the production costs, decrease the burden of death rate, detection of the bee colony swarming and increase of the whole bee hive production (Zacepins et al., 2020).

Authors of this paper would like to discuss and evaluate the economic aspect of the remote bee colony monitoring system implementation to the beekeeping practice. Specific aim of this paper is to present an approach for evaluation of the economic gains of the bee colony remote monitoring system implementation for real-time and remote bee colony monitoring procedures.

Material and methods

This section describes approach and methods used for the evaluation of the economic gains of the bee colony remote monitoring. This section describes the basic beekeeping expenses by taking the Latvian beekeeper as an example. Different used variables are defined and assumed either on literature study or available resources, either on individual beekeeper knowledge.

For the evaluation of possible benefits by implementing the remote bee colony monitoring, possible amount of EUR values are compared. As well return of investment (ROI) coefficient is calculated to show the possible outcome of the investments of the monitoring system. Different monitoring system configuration scenarios are compared to demonstrate how the profit and installation costs changes.

Description of basic beekeeping expenses

To evaluate the economic gains of the bee colony remote monitoring it is necessary to understand which expenses positions/situations can be affected by the IT system implementation. At the beginning authors would like to describe the overall situation of the hobbyist beekeeper in Latvia (should be similar also to other beekeepers in other countries) and identify its essential expenses. These costs will be used for further comparison and evaluation. Cost are valid for observed cases but may differ between beekeepers. Some numbers are taken into consideration based on beekeeper's advice and/or based on literature studies. Usually beekeepers are not placing more than 20 bee hives in one location, so authors consider that small hobbyist beekeeper have 20 bee colonies (variable: *NumOfCol*) located in one remote location. Distance to the apiary mostly are not more than 50km. Average honey production per bee colony is considered to be 25kg (variable: *Prodcol*), based on beekeeper's survey, made by Latvian beekeeper's association (http://www.strops.lv/index.php/raksti/dravosanas-panemieni/467-lbb-biskopju-aptaujas-rezultatu-apkopojums). Price per 1kg of honey is considered to be 4.50 EUR (variable: *Phoney*), (based on http://laukos.la.lv/biskopji-spej-tik-medu-sviest). For basic income (variable: INC_{bas}) calculation following formula is used:

INC_{bas} =NumOfCol*Prodcol*Phoney = 2250 EUR

Authors would like to define basic beekeeper expenses positions. Authors in this paper only assume positions which potentially can be affected by the implementation of the remote monitoring systems and expenses for equipment, medicine for the bee colonies, etc. are not considered as IT systems will definitely not affect them.

First considered expenses are costs for the remote apiary inspections. These costs can be calculated by taking into account distance to the apiary and wage costs for workers, so expenses consist of two parts: one related to travel costs including car fuel consumption and second related to labour costs. To calculate expenses related to the fuel consumption the distance to the apiary is needed, car fuel consumption per 100km and fuel price. As an alternative, constant costs for kilometre allowance can be used for calculations. For labour related expenses, time for inspection, time for travelling to apiary and person (or persons) wage should be considered. If beekeeper do not want to consider the time spent for work, labour related costs are zero. We propose the following formula for calculation of the expenses to reach the apiary and make the inspection. Default values for variables are also defined:

$Exp_{inspection} = Exp_{fuel} + Exp_{pers}$, where

$Exp_{fuel} = Dist*Fuel_{cons}/100*Fuel_{price}$

Dist = Distance to the apiary (km) = 50 km

$Fuel_{cons}$ = Car fuel consumption to 100km (L) = 8 L

$Fuel_{price}$ = Price of one Liter fuel = 1.20 EUR

$Exp_{pers} = \sum_i^n (Perstime * Pershour)$, where

n = Number of persons going to the apiary = 1 pers

$Pers_{time}$ = Time needed to make a whole inspection (including travelling time) = 120 min for travelling + 200 min for inspection (10min*20).

$Pers_{hour}$ = Salary for one person hour = 5.36 EUR

Costs for one inspection based on provided variables can be calculated as follows:

$Exp_{inspection}$ = (100*8/100*1.2 + 1*320/60*5.36) = 9.6 + 28.59 = 38.19 EUR

It is assumed that beekeepers in average are making 12 inspections (variable: *NumOfInsp*) during the year and thus overall costs for inspection during the year can be calculated as follows:

$Exp_{inspections} = Exp_{inspection}$ * NumOfInsp

Yearly expenses for observed case would be: $Exp_{inspections}$ = 38.19 * 12 = 458.24 EUR

Next aspect that generate loses for the beekeeper is death/disappearing/Colony collapse disorder of the colony (variable: Expdeath): Expdeath = NumOfCol*Ratedeath*Pcolony

Authors assume value of one colony death equal to 140 EUR (variable: Pcolony). Average bee colony death rate is 20% (variable: Ratedeath), which results in death of 4 colonies and lead to losses of 560 EUR.

The last aspect which is considered for the calculations are expenses, generated by the swarming of the colonies. Average swarming rate is 10% (variable: Rateswarm), which results in swarming of 2 colonies and lead to losses of 212.50 EUR, assuming, that value of one swarmed colony is 106.25 EUR (variable: Pswarm) (A. Zacepins et al., 2020).

$Exp_{swarm} = NumOfCol*Rate_{swarm}*P_{swarm}$

Summarising all mentioned expenses positions the total expenses can be calculated:

Exp_{total} = 458.24 + 560 + 212.50 = 1230.74 EUR

So basic profit (variable: Profit) for the beekeeper is:
$Profit = INC_{bas} - Exp_{total} = 2250 - 1230.74 = 1019.26$ EUR

Results and discussion

As a result of this research and scientific paper are:

- proposed model (algorithm) for evaluation of benefits by implementing the remote bee colony monitoring system;
- assessment of the ROI coefficient which includes costs of the monitoring system itself, installation and maintenance costs;
- comparison of expenses and benefits of different configuration of bee colony monitoring systems;
- developed Web application to ease the evaluation of the economic gains of the bee colony remote monitoring.

Evaluation of possible benefits by implementing the remote bee colony monitoring

By implementing IT system for the bee colony remote monitoring beekeeper can significantly decrease the number of on-site inspections, thus minimising the costs for going to the remote apiary. It can be achieved by the real-time colony status monitoring and notifications if on-site actions are required.

Apiary inspections could be divided in two groups: inspections that are mandatory on-site (cannot be substituted by any remote methods) and those can be replaced with remote monitoring system. Mandatory on-site inspections are: after winter inspection, adding supers, honey harvest, varroa treatment during summer and varroa treatment during winter. And the second group are inspections to monitor colony productivity and status, like checking if there is enough winter feed, is there a nectar flow and bee health status. Those inspections can be substituted by the remote system, which is able to monitor those situations. For example, nectar flow can be easily monitored by the scales system, activity can be checked by temperature/sound, winter food consumption by scales/temperature. Number of inspections in second group depends on the individual beekeeper and on beekeeping approach, but authors assume that this number on average is 5 inspections per year (based on individual interviews with the beekeepers). As a result, beekeeper can save up to 5 (variable: *NumOfInsp*) visits to the apiary during a year, thus having savings: $5 * 38.19 = 190.95$ EUR.

Additional benefit of the real-time bee colony monitoring can be minimisation of the bee colony death rate by instant alarms and continuous bee colony monitoring. Potential decrease of death rate depends from actions taken after receiving the alarm notice. Based on https://apistech.eu/en/hive-monitor-2/ decrease of 20% can be achieved. So, the number of colonies dying each year can be decreased by 20%, thus saving can be calculated as: Round $(4 * 0.2) * 140 - 38.19 = 101.81$ EUR.

Notifications from monitoring system can warn about upcoming swarming event. Economic benefit of one colony swarming (variable: *BnfOfSwarming*) detection is evaluated in another authors paper (A. Zacepins et al., 2020) and that approach can be used to calculate benefits of one bee colony swarming detection. Thus, saving of additional 150.42 EUR will happen.

Location, weather and other factors determine volumes of produced honey. Monitoring system provide data for decisions and actions that potentially can lead to increased production volumes. According to literature and commercial bee colony monitoring system web site (https://apistech.eu/en/hive-monitor-2/) it is evaluated, that increase up to 25% can occur. Total benefits can be calculated from average yearly honey production volume and price per litre.

$Bnf_{prod} = NumOfCol*Prod*0.25*P_{honey}$, where

NumOfCol = number of colonies
Prod = Amount of production in kg (25kg average)
P_{honey} = Honey price per kg (4.50 EUR)
Bnf_{prod} = 20*25*0.25*4.50 = 562.50 EUR
Summarising all calculations, overall benefits expressed in EUR per year of remote monitoring system can be as follows: $Bnf_{sys} = Bnf_{inspection} + Bnf_{death} + Bnf_{swarming} + Bnf_{prod}$
Bnf_{sys} = 190.95 + 101.85 + 150.42 + 562.50 = 1005.72 EUR
According to these calculations, implementation of IT system gives additional economic benefit by reducing potential loses. To calculate ROI of monitoring system, the total costs of ownership (TCO) must be calculated first. TCO expenses include IT system purchase, installation and maintenance costs.

Overview of the commercial bee colony monitoring systems

To evaluate the economic gains of bee colony monitoring system the price of such system, its operation and maintenance costs must be known. Today on the market there are various different bee colony monitoring and measurement systems available. Authors aim is not to name and review all of them, but choice is based on random search results. As a requirement for the system is ability to measure at least temperature and weight of the bee colony with an option to remotely access the data. Some examples of available systems are:

- https://www.wolf-waagen.de / price: 899 EUR per device, 24 EUR/year for software, 15 EUR/year for data transmission
- www.bienenwaage.de Capaz GSM 200 / price: 1310 EUR per device, additional costs for data transmission
- http://www.arnia.co.uk/hive-scales/ / price: 380 EUR per device, 5 EUR/month for data subscription
- https://pollenity.com/product/beebot/ / price: 315 EUR per device, 189 EUR for additional device without scales
- https://solutionbee.com/ /SolutionBee HM-5 Hive Monitor / price: 290 EUR
- https://broodminder.com/ BroodMinder-Citizen Science Kit/ price: 289 EUR

It can be concluded that minimal price for the bee colony system for weight and temperature monitoring is around 289 EUR per unit/hive. Based on previous calculations, benefit of such system implementation is 1005.72 EUR per year. But now considering system costs, the ROI can be calculated as follows:

Costs = 20 * 289 = 5780 EUR (to deploy system for all hives) and
ROI = 5780 / 1005.72 = 5.75 years

Based on provided calculations it can be concluded, that it is not economically feasible to install such system on all hives, as ROI equal to such huge number is not feasible for the beekeepers. Based on consultations with the beekeepers it is concluded, that usually advanced beekeepers install only one system per apiary (per remote location) and monitors weight of one target colony, assuming that other colonies would behave almost similar. Such approach can provide benefit of production increase of approximately 15% and evaluating it in EUR:
$Bnf_{prod} = NumOfCol*Prod*0.15*P_{honey}$ = 20 * 25 * 0.15 * 4.50 = 337.5 EUR
ROI in this case would be 0.86 years, that is a good achievement, but all benefits related to decrease of the death rate, decrease of inspections and minimisation of swarming also disappear in this case.
Authors thoughts are that the best option for the beekeepers to fully utilize the potential of monitoring system and get all the benefits is to use custom configuration of the devices for bee colony real-time remote monitoring. In this configuration there would be one main automatic device to monitor weight changes installed on one control hive, but other hives would be equipped with temperature and/or sound/vibration sensors for swarming detection

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and constant monitoring (Aleksejs Zacepins et al., 2016). Connection of sensors can be wired or wireless. Then beekeeper will gain all benefits of swarming detection, minimisation of death and increase in production. In that case system installation costs would be up to 500 EUR (300 EUR main module, 10 EUR per hive additional costs), but benefits would be 1005.72 EUR (as calculated previously). In that way, the period of return of investment would be within one year.

Table 1 below summarises all calculations and gives overview of benefits using different system configurations:

Used variables are:

- NumOfHives - 20
- PriceHoney - 4.5 EUR
- InspectionCost - 38.19 EUR
- Value of the dead colony - 140 EUR
- Swarming value - 106.25

Table 1. Comparison of expenses with different system configurations

	Without IT system	All hives with measuring system	One hive with system	Apiary with custom config
Production per hive	25	31.25	28.75	30
Basic income	2250	2812.50	2587.50	2700
Expenses				
Number of inspections	12	7	12	7
$EXP_{inspections}$	458.24	267.31	458.24	267.31
Number of dead colonies	4	3	4	3
EXP_{dead}	560	458.19	560	458.19
Number of swarmings	2	0	2	0
$EXP_{swarming}$	212.50	0	212.50	0
EXP_{total}	1230.74	725.50	1230.74	725.50
Profit and system installation costs				
Profit	1019.26	2087.00	1356.76	1974.50
Installation costs	-	5780	289	500

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Web application to ease evaluation of the economic gains of the bee colony remote monitoring

To ease the process of calculation of all formulas and evaluate the economic gains of the implementation of bee colony remote monitoring system, online web tool (application) is developed and published for public use (https://sams.science.itf.llu.lv/system-eval/). Calculator is pre-filled with default values, and user can change them to adapt for local requirements (needs, peculiarities) and prices (costs). The web tool was built as a single page application using Spring Boot 2 framework (forming back-end) and Angular 6 framework with Bootstrap 4 library to create the client side (front-end) of the application. Result is calculated simultaneously as soon as the required fields are filled. A screenshot of the developed web tool is shown in Figure 1 below:

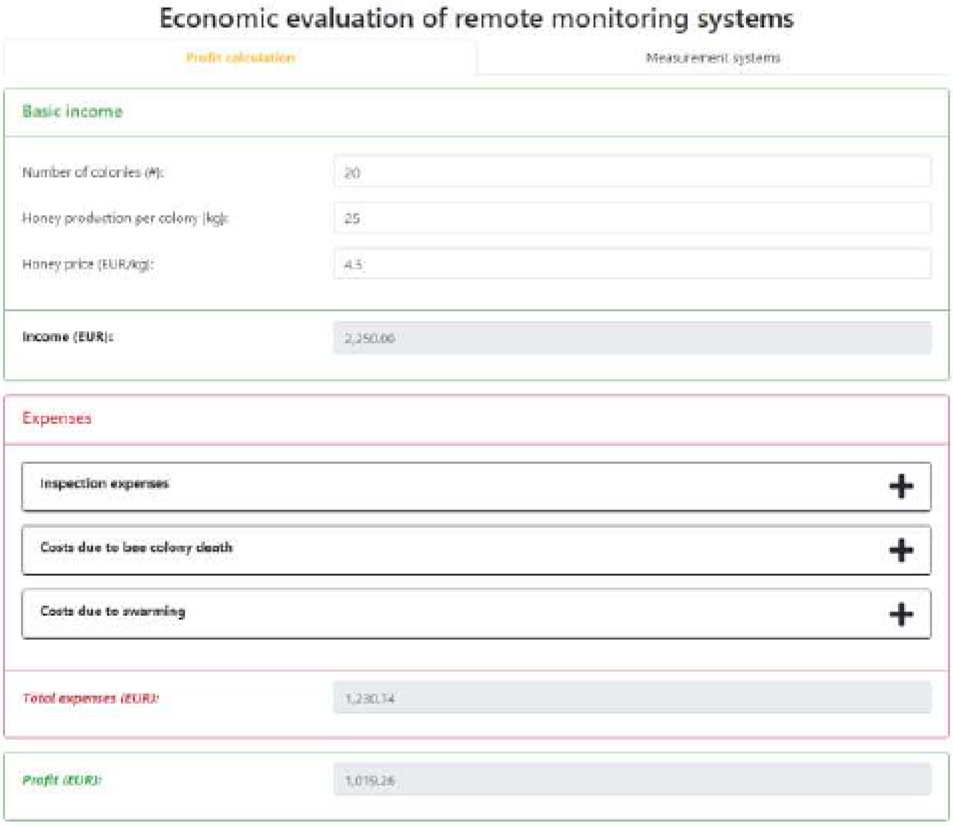

Figure 1. Demonstration of the developed web tool for calculations

Conclusions

The advantage of Precision Beekeeping is the possibility to detect changes or problems in the bee colonies at an early stage giving the beekeeper the possibility to take countermeasures to save bee colonies.

Modern beekeeping and smart apiary management cannot be done without application of information and communication technologies, but each individual beekeeper should specify

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what systems he needs most. Implemented systems should minimize the number of on-site inspections of colonies, and maximize colony health and productivity.
Based on made calculations and assumptions it can be concluded that beekeepers need configurable bee colony monitoring system with cheap measurements of all colonies and one basic module for in-deep monitoring of referenced colony within one remote apiary.
To improve the precision of proposed economic evaluation in long term, system repair and additional maintenance costs should be considered.

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References

Aizen, M. A., & Harder, L. D. (2009). The Global Stock of Domesticated Honey Bees Is Growing Slower Than Agricultural Demand for Pollination. *Current Biology*, *19*(11), 915–918. https://doi.org/10.1016/j.cub.2009.03.071

Bromenshenk, J. J., Henderson, C. B., Seccomb, R. A., Welch, P. M., Debnam, S. E., & Firth, D. R. (2015). Bees as Biosensors: Chemosensory Ability, Honey Bee Monitoring Systems, and Emergent Sensor Technologies Derived from the Pollinator Syndrome. *Biosensors*, *5*, 678–711. https://doi.org/10.3390/bios5040678

Gallai, N., Salles, J., Settele, J., & Vaissière, B. (2008). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, *68*, 810–821.

Human, H., & Brodschneider, R. (2013). Miscellaneous standard methods for Apis mellifera research. *Apicultural Research*, *52*(4), 1–53.

Kaplan, J. (2008). Colony Collapse Disorder. A Complex Buzz. *Agricultural Research Magazine*, *56*(5), 8–11.

Klein, A.-M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. a, Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings. Biological Sciences / The Royal Society*, *274*(1608), 303–313. https://doi.org/10.1098/rspb.2006.3721

Komasilovs, V., Zacepins, A., Kviesis, A., Fiedler, S., & Kirchner, S. (2019). Modular sensory hardware and data processing solution for implementation of the precision beekeeping. *Agronomy Research*, *17*(2), 509–517. https://doi.org/10.15159/AR.19.038

Kridi, D.S., de Carvalho, C. G. N., & Gomes, D. G. (2014). A predictive algorithm for mitigate swarming bees through proactive monitoring via wireless sensor networks. *Proceedings of the 11th ACM Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, & Ubiquitous Networks*, 41–47.

Kridi, Douglas S., de Carvalho, C. G. N., & Gomes, D. G. (2016). Application of wireless sensor networks for beehive monitoring and in-hive thermal patterns detection. *Computers and Electronics in Agriculture*, *127*, 221–235. https://doi.org/10.1016/j.compag.2016.05.013

Meikle, W. G., & Holst, N. (2015). Application of continuous monitoring of honeybee colonies. *Apidologie*, *46*(1), 10–22. https://doi.org/10.1007/s13592-014-0298-x

Ollerton, J., Winfree, R., & Tarrant, S. (2011). How many flowering plants are pollinated by animals? *Oikos*, *120*(3), 321–326. https://doi.org/10.1111/j.1600-0706.2010.18644.x

Potts, S. G., Imperatriz-Fonseca, V. L., Ngo, H. T., Biesmeijer, J. C., Breeze, T. D., Dicks, L. V., … Viana, B. F. (2016). *IPBES (2016): Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*.

Sánchez, V., Gil, S., Flores, J. M., Quiles, F. J., Ortiz, M. A., & Luna, J. J. (2015). Implementation of an electronic system to monitor the thermoregulatory capacity of honeybee colonies in hives with open-screened bottom boards. *Computers and Electronics in Agriculture*, *119*, 209–216. https://doi.org/10.1016/j.compag.2015.10.018

Zacepins, A., Kviesis, A., Komasilovs, V., Komasilova, O., Susilo, F., Wakjira, K., & Brodschneider, R. (2020). When it pays to catch a swarm - evaluation of the economic importance of remote honey bee (Apis mellifera) colony swarming detection. *Precision Agriculture (Submitted for Review)*.

Zacepins, A., Brusbardis, V., Meitalovs, J., & Stalidzans, E. (2015). Challenges in the development of Precision Beekeeping. *Biosystems Engineering*, *130*, 60–71. https://doi.org/10.1016/j.biosystemseng.2014.12.001

Zacepins, A., Kviesis, A., Ahrendt, P., Richter, U., Tekin, S., & Durgun, M. (2016). Beekeeping in the future – smart apiary management. *ICCC 2016*, 808–812.

Zogovic, N., Mladenovic, M., & Rašić, S. (2017). From Primitive to Cyber-Physical Beekeeping. *7th International Conference on Information Society and Technology*, 38–43.

2.13 October 2020 – Implementation of the Precision Beekeeping system for bee colony monitoring in Indonesia and Ethiopia

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***Abstract*—Successful implementation of the Precision Beekeeping system includes development of the bee colony monitoring hardware and software for data collection and analysis. This paper focuses on development and installation of such system in two developing countries: Ethiopia and Indonesia. Challenges and peculiarities of the mentioned countries are compared and described in regards of the system installation process, beekeeper's apiary management practices and economic aspects. Bee colony monitoring hardware is based on Raspberry Pi Zero W single board computer as a main controller of the system and connected sensors for temperature, humidity, weight and acoustics. Software part includes cloud-based data warehouse solution with additional models for data analysis and web interface for the remote data monitoring and visualisation. Authors' approach is presented for linking together hardware components with a cloud software into single solution oriented on user needs in target countries. Main purpose of Precision Beekeeping systems is detecting the actual status of the colony and informing the beekeeper in case if unwanted colony behaviour occurs. Another significant aspect of the research is evaluation of the possibility to transfer knowledge and expertise to the experts in target countries. This work is carried out within the SAMS - Smart Apiculture Management Services project, which is funded by the European Union within the H2020-ICT-39-2016-2017 call. To find out more visit the project website https://sams-project.eu/.**

***Index Terms*—Precision Beekeeping, Precision Apiculture, Bee colony monitoring, Smart beekeeping, SAMS project**

I. Introduction

Importance of the bee health and sustainable beekeeping are widely discussed, as bee population is decreasing worldwide [1], [2]. In developed countries beekeepers implement various information technology solutions for constant bee colony monitoring thus facilitating the development of the Precision Beekeeping. In some countries beekeepers surveys are completed to summarize the status of the Precision Beekeeping development [3]. As defined by [4] Precision Beekeeping is an apiary management strategy based on the monitoring of individual bee colonies to minimise resource consumption and maximise the productivity of bees. Situation with the Precision Beekeeping in developing countries is different, for instance beekeepers in Ethiopia and Indonesia do not use any remote monitoring systems and make a management decision based on on-site visual observations of the colonies and manual inspections of the bee colonies itself. Some reasons for that are, lack of technical expertise in field of information

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technologies, networking and communication, as well costs for such system implementation and maintenance sometimes are very high. Frequent physical inspections of bee colonies interferes bees and can cause additional stress, that negatively affects the whole colony productivity [5].

A combined biological, sociological and technical approach is made within the SAMS - Smart Apiculture Management Services - project (https://sams-project.eu/). The SAMS project is funded by the European Union within the H2020-ICT-39-2016-2017 call. It enhances international cooperation of ICT and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".

One of the SAMS project tasks is to develop an enhanced beehive system and service for real-time constant bee colony monitoring. This system should help to optimize beekeeping operational costs and minimise colony losses, thus increasing the profitability and sustainability of beekeeping.

Aim of this paper is to describe developed solution for bee colony monitoring and evaluate challenges in such system implementation in two developing countries: Ethiopia and Indonesia.

II. Beekeepers Challenges in Indonesia

In Indonesia beekeepers usually places Apis Cerana colonies in deep jungles (forests) with distance up to 50-100m between individual colonies and inspection of all those geographically disseminated colonies is very time consuming. With the help of the remote monitoring system beekeeper can identify which hives really needs an inspection, thus saving work time.

Another aspect in Indonesia is that Apis Mellifera beekeepers must use migratory beekeeping method, which means that beekeepers often change the location of their apiaries. This happens because foraging resources are limited in every location and to provide food for the colonies beekeepers have to search for a suitable place for an apiary.

Regular apiary checks should be made as sometimes theft of the bee hives are happening and interruption of the remote measurements should be as an indicator for this, and beekeeper will be able to react immediately.

In Indonesia bee colonies tend to abscond. Biological definition of the absconding comprises the departure of all adult bees of a colony from their nest, leaving behind whatever brood and stores are in it. Absconding may be due to shortage of food, to disturbance, or to other adverse circumstances [6]. That's why Indonesian beekeepers have to check the apiaries constantly to identify this. Remote monitoring system can alert the beekeeper when the bees abscond.

III. Beekeepers Challenges in Ethiopia

One of the major problems of the beekeeping in Ethiopia discovered by the beekeepers is the aggressive behaviour of local honeybees. In case of this fact, it is almost impossible to inspect the colonies during the daylight, that's why they make visual observations of the colonies during the night. Monitoring system can significantly minimise the number of visual inspections.

Absconding of the bee colonies is also a problem. As mentioned previously, aggressive bees should be kept away from homestead, sometimes bee colonies are placed in hardly reachable locations and often travelling to such locations are costly. As a result, beekeepers will not visit the beehives on regular bases. So, absconding of the bees will be recognized after the empty hives already attacked by wax moth and this may reach up to 40 % on average.

There are some beekeepers that use additional help from extension workers to make inspections of the colonies, so minimisation of inspections will basically lead to decrease of costs.

Concluding above mentioned challenges and beekeeper needs in both countries it is decided to propose a solution primary for temperature and weight monitoring of the colonies. These two parameters are enough to measure in this case. Based on temperature monitoring it is possible to conclude about death or absconding of the colony. Basically, temperature is the most commonly used metric in Precision Beekeeping [7]–[10]. Weight measurements give an overview of the nectar flow and start / end period of the foraging activity [11], [12]. For additional scientific needs system is also capable of recording sound of the colony and humidity. Proposed SAMS HIVE system consists of three main parts: hardware solution for physical measurements, software part for data storage and analysis and front-end system for the end-users.

IV. Sams Hive Measurement Device

Important functional part of the hardware is the power supply. SAMS HIVE system is powered by a photovoltaic system as beekeepers in Ethiopia and Indonesia places hives in rural areas where standard power supply is not available and during a foraging season beekeepers are forced to reallocate bee colonies several times. Power unit consists of the standard components: solar module, charging controller and battery. The size and capacity depends on the location, the number of connected measurement units and the data measuring intervals. The power unit also supplies a mobile GSM Wi-Fi router which is used as a hotspot for the monitoring units to transfer data to a SAMS data warehouse (described later).

Other functional groups are (1) the central computer unit where the sensors are connected, (2) the sensor frame with temperature sensor and microphone placed in the beehive as well as (3) the scale unit placed beneath the beehive with outdoor temperature and humidity sensor (see Figure 1.).

The monitoring unit consists of a printed circuit board (PCB) with Raspberry Pi single board computer, a step-down converter to change the voltage of the power unit to 5V as well as an analog-to-digital converter (ADC) that converts signals of the load cell. The load cell measures the weight of the colony. Additionally a sensor frame is connected to the computer and includes temperature sensor and microphone

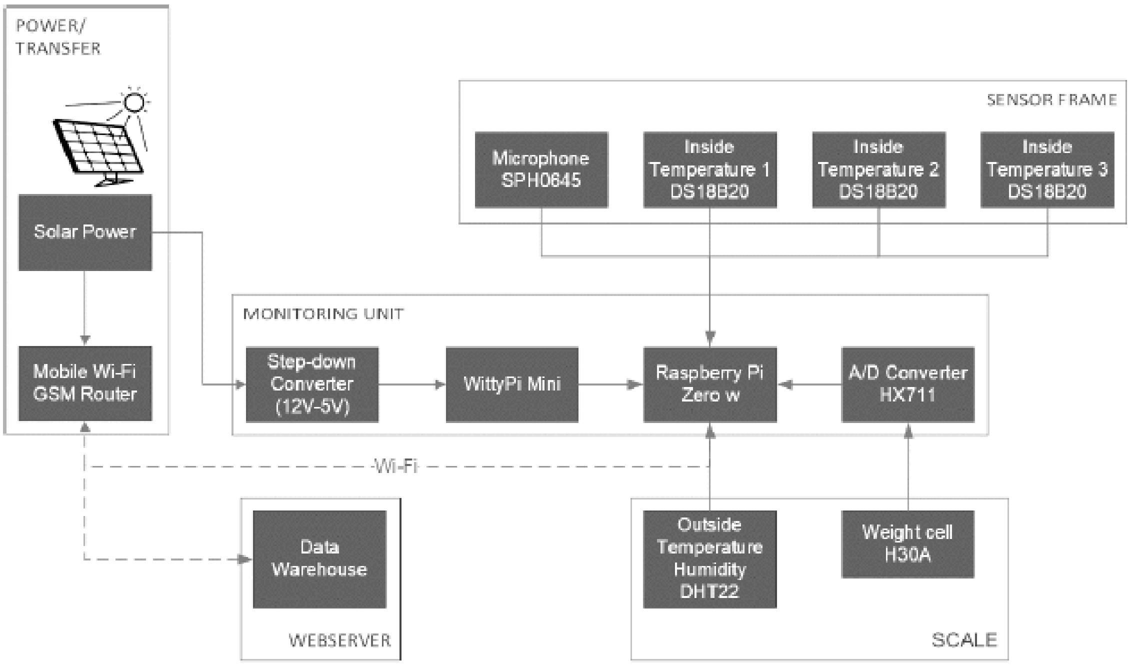

Fig. 1. Flow chart of the SAMS HIVE System with Power unit, Scale unit and Sensor frame

as well as a humidity sensor optionally. The acoustics are recorded over a certain timespan and uploaded as Fast Fourier Transformed (FFT) spectrum. It is recorded with 16 kHz sampling frequency, covering a frequency range from 0 kHz to 8 kHz. In order to obtain local data on air temperature and humidity, sensors can be connected and positioned outside the beehive.

After successful recording, the data is transferred via Wi-Fi to the mobile GSM router and sent to the web server (data warehouse) (see Figure 1 and Figure 2). If the upload is not possible, the data remains on the SD card until a successful upload has been performed. In this case, a new upload attempt starts after a certain time. Each device has its own ID (identifier) so that it can be uniquely assigned on the data warehouse (DW). Individual sensors can also be added to users, locations or groups on the DW. Successful recording, data storage, uploads or errors are logged and also transferred to the web server. Events for troubleshooting can be viewed there by administrators. On the device, 2 LEDs indicate working or deep sleep mode. Plug connections ensure easy installation. The sensor frame is connected via a 9-pin D-Sub connector. A standard DC power plug was selected for the power supply. The open source code to run the SAMS HIVE monitoring system can be found at https://github.com/sams-project.

The recommended installation for sensors is to use a sensor frame above the brood chamber (see Figure 3). The sensors are

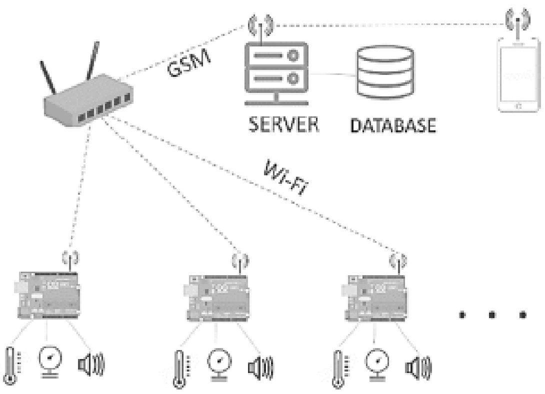

Fig. 2. Connection of internet-compatible devices

installed centrally in the frame so that they are located above the brood nest. This allows the use of the natural heat flow. The size of the sensor frame should not exceed the height of the species-specific "bee space", otherwise there might occur problems due to natural honeycomb construction of the bees. Sensors should be covered with a close-meshed grid (mesh size < 0.2mm), otherwise wax bonding and propolisation of the mesh could result. The frame is placed horizontally on the brood chamber and the sensors are connected via cable to the PCB with the computer unit. To place the computer unit, the space between the upper and lower plate of the scale can be used. The scale is located under the beehive (see Figure 3).

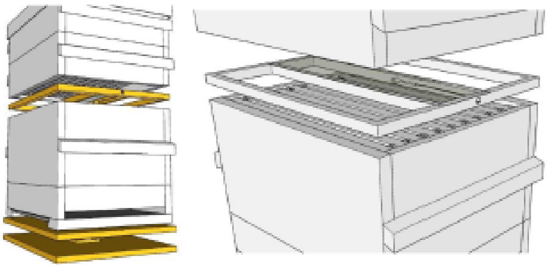

Fig. 3. Sensor placement in extra sensor frame between honey and brood chamber as well as scale below the brood chamber

Current price of the SAMS HIVE monitoring system hi-fi prototype is about 170 €. In addition there are the expenses for power supply and GSM. The dimensioning of the photovoltaic system for power supply depends on the location, the number of monitoring units and the measuring intervals but is about 200 € for up to ten monitoring units. The overall costs are still relatively high also due to the photovoltaic system. To gain information for an improvement of the bee colony management only one SAMS system per apiary or even a shared system could already be sufficient.

In order to enable a long-lasting hardware usage, qualitative components have been selected. The components are robust, durable and can also be used for other purposes. The design is suitable for a simple deconstruction of the components. A repair and recycling plan should support this if necessary. The computer can easily be extended with additional sensors. For example, it is possible to connect a small weather station to collect region-specific weather data. It is also possible to connect several temperature sensors. In addition to its expandability, the system can also be used for other academic and research applications as well as for bee institutes to collect sensor data.

V. SAMS Data Warehouse

For the purpose of the bee colony data storage and analysis, data management solution for the SAMS system was developed. It is based on several main functional requirements:

- system should be able to get data from many hive monitoring systems with possible different configurations
- system should be able to store and process bee colony data based on pre-defined rules
- system should provide interface for data output and visualisation

Authors decided to call developed solution as data warehouse (DW). Data warehouse is an intermediate layer between data provider systems and data consumer systems or end-users [13]. DW is developed with main aim to help beekeepers run the apiary more effectively by utilising higher amount of available data and accumulated data interpretation knowledge. DW architecture is developed taking into account flexibility and extensibility of three data management stages:

- data input functionality is accepted from different data sources (can be uploaded manually or automatically)
- data storage facility is suitable of different bee colony measurement types and formats with different data time granularity (minute, hour, day)
- data processing functionality is built using the modular approach for flexible aggregation and modelling pipelines

In overall DW is built in the way that incoming data are processed almost immediately by involving different models for data aggregation and reporting. Modular architecture of the solution ensures isolation boundaries both for reliability reasons, maintenance and development considerations [14].

For the sake of communication efficiency and to address offline operation cases for HIVE hardware data-in package schema is demonstrated in Figure 4.

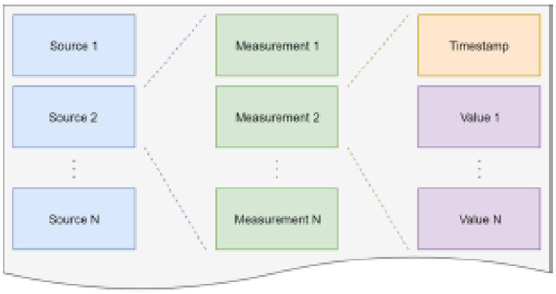

Fig. 4. Demonstration of hardware data-in package schema

Such schema allows HIVE devices to send readings from multiple sources (usually sensors) during a single communication session. Single data package supports multiple measurements for each source, where each measurement has timestamp and one or more numeric values. This approach makes it possible for HIVE devices to operate in offline mode, perform sensor measurement recordings in needed frequency and communicate with DW according most efficient schedule or when connection is available.

VI. Example of the User Interface

Data warehouse provides REST API for configuration, data-in and data-out operations. Thus, DW can be accessed by any user and/or unmanned system, but main aim was to provide an option for creating different and custom end-user interfaces, for instance localized mobile and Web application. At this moment, for demonstration and scientific purposes a single page Web application was developed. It has basic functionality and provides a graphical interface for DW configuration maintenance, for accessing stored information and generate different reports. For front-end development Angular and Bootstrap frameworks were used. An example of dashboard

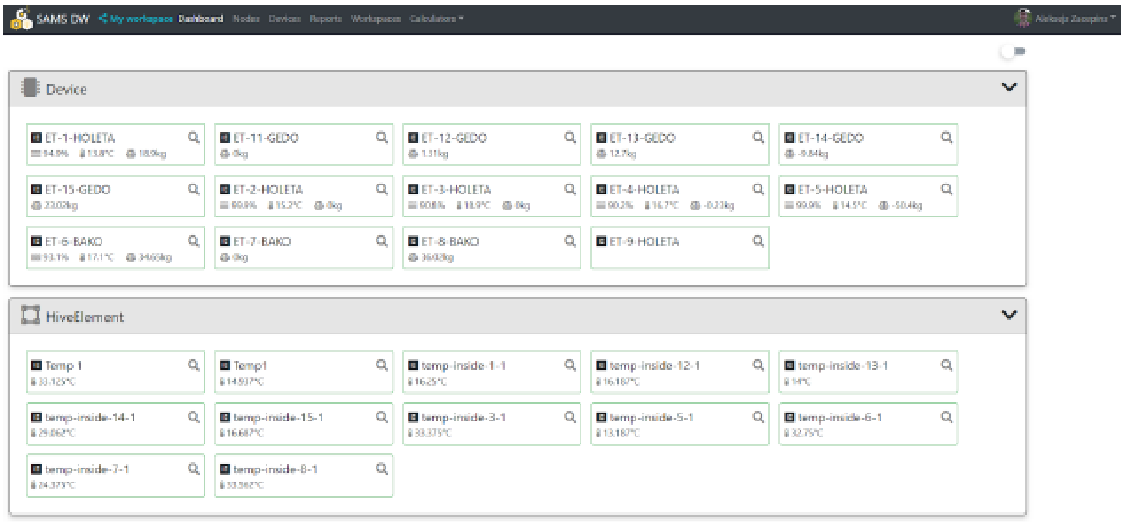

Fig. 5. Example of WEB system dashboard with installed devices in Ethiopia

shows oversee of Ethiopian apiaries and active devices and sensors (see Figure 5.)

Unfortunately, it was discovered that Ethiopian and Indonesian beekeepers are not interested in deep data analysis of the measured data. They need easy and understandable interface for bee colony state visualisation. As smartphones are widely used in these countries, more often than stationary PC or laptops, there should be adaptable Web system or a smartphone app for data observation. Development of such application for the beekeepers is in authors future plans.

VII. Challenges for System Implementation and Operation

At this moment, three apiaries in Ethiopia are equipped with the SAMS HIVE system: Bako (three systems), Gedo (five systems) and Holeta (five systems). Due to challenges in maintaining stable connectivity and a lack of IT expertise near the installation sites of Holeta and Gedo for applying a quick solution/ fixing the problems only three systems deployed in Bako are active at the moment. In Indonesia, five measurement systems are installed in different geographical locations (two in Ciwidey, one in Tanikota, two in Ciburial).

One of the challenges for both countries is a mobile network operation for data transmission. Network stability issues and frequent interruptions have been observed.

One significant issue is the system maintenance in these countries as beekeepers lack the technical information, technology skills and fixing some technical problems related to the hardware is complicated process, as attracting external technical staff is complicated too. To minimise this factor and facilitate the local development of the Precision Beekeeping system, SAMS project members organised local workshops, where together with the specialists and beekeepers learn how to assemble and install the system.

One more issue that should be mentioned is system components availability in the target countries and cost of those components. Sometimes it is very challenging to get the needed parts for the system development.

Conclusions

Implementation of the Precision Beekeeping system allows to decrease the number of the visual on-site observations of the bee colonies and helps to detect abnormal behaviour of the colonies and could help to prevent death, absconding, colony collapse disorder (CCD) of the bee colonies.

Implementation of the bee colony monitoring system to facilitate the development of the Precision Beekeeping in Ethiopia and Indonesia is necessary and have added value for the beekeepers. Still intensive transfer of knowledge is needed to facilitate the understandability of the benefits provided by the remote bee colony monitoring systems, including the economic benefits for implementation of such systems.

Acknowledgment

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References

[1] J. Kaplan, "Colony Collapse Disorder. A Complex Buzz," Agricultural Research Magazine, 56(5), pp. 8–11, 2008.

[2] N. Gallai, J. M. Salles, J. Settele and B. E. Vaissière, "Economic valuation of the vulnerability of world agriculture confronted with pollinator decline," Ecological economics, 68(3), pp.810-821, 2009. doi: 10.1109/ISSC.2015.7163763.

[3] A. Zacepins and V. Brusbardis, "Precision beekeeping (precision apiculture): research needs and status in Latvia," The Journal 'Agriculture and Forestry', 61(1), pp. 135–141, 2015. doi: 10.17707/AgricultForest.61.1.17.

[4] A. Zacepins, V. Brusbardis, J. Meitalovs and E. Stalidzans, "Challenges in the development of Precision Beekeeping", Biosystems Engineering, 130, pp. 60–71, 2015. doi: 10.1016/j.biosystemseng.2014.12.001.

[5] A. Zabasta, A. Zhiravetska, N. Kunicina and K. Kondratjevs, "Technical Implementation of IoT Concept for Bee Colony Monitoring", in In 2019 8th Mediterranean Conference on Embedded Computing (MECO), pp. 1–4, 2019. doi: 10.1109/meco.2019.8760180.

[6] E. Crane, "Bees and beekeeping: science, practice and world resources," Heinemann Newnes, 1990.

[7] A. Zacepins and T. Karasha, "Application of temperature measurements for the bee colony monitoring: a review," in Proceedings of the 12th International Scientific Conference 'Engineering for Rural Development'. Jelgava, Latvia, pp. 126–131, 2013.

[8] A. Zacepins and J. Meitalovs, "Implementation of multi-node temperature measurement system for bee colonies online monitoring," Control Conference (ICCC), 2014 15th International Carpathian, pp. 695–698, 2014.

[9] W.G. Meikle and N. Holst, "Application of continuous monitoring of honeybee colonies," Apidologie, 46(1), pp. 10–22, 2015. doi: 10.1007/s13592-014-0298-x.

[10] W. G. Meikle, M. Weiss, P. W. Maes, W. Fitz, L. A. Snyder, T. Sheehan, B. M. Mott and K. E. Anderson, "Internal hive temperature as a means of monitoring honey bee colony health in a migratory beekeeping operation before and during winter," Apidologie, 48(5), pp. 666–680, 2017. doi: 10.1007/s13592-017-0512-8.

[11] D. W. Fitzgerald, F. E. Murphy, W. M. Wright, P. M. Whelan and E. M. Popovici, "Design and development of a smart weighing scale for beehive monitoring," in 2015 26th Irish Signals and Systems Conference, ISSC 2015, pp. 1–6. doi: 10.1109/ISSC.2015.7163763.

[12] Z. Y. Ruan, C. H. Wang, H. J. Lin, C. P. Huang, Y. H. Chen, E. C. Yang, C. L. Tseng and J. A. Jiang, "An Internet of Things-Based Weight Monitoring System for Honey," International Journal of Agricultural and Biosystems Engineering, 11(6), pp. 478–482, 2017.

[13] B. H. Inmon, "Data Warehousing, 2.0 Modeling and Metadata Strategies for Next Generation Architectures," Architecture, pp. 1–13, 2010.

[14] V. Komasilovs, A. Zacepins, S. Kirchner, A. Kviesis, and S. Fiedler, "Modular sensory hardware and data processing solution for implementation of the precision beekeeping," Agronomy Research, 17(2), pp. 509–517, 2019. doi: 10.15159/AR.19.038.

2.14 December 2020 – Temperature and Weight Monitoring of the Apis Cerana Bee Colony in Indonesia

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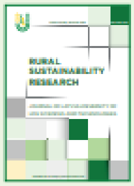

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Temperature and Weight Monitoring of the Apis Cerana Bee Colony Indonesia

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Abstract. Remote and automatic monitoring of two Apis Cerana bee colonies was conducted in Indonesia to demonstrate precision beekeeping approach in that region. Successful implementation of the precision beekeeping system includes development of the bee colony monitoring hardware and software for data collection, analysis and visualisation. This paper focuses on development and installation of such systems at the private apiary in Indonesia. For bee colony monitoring at the apiary a developed monitoring unit was used, which is based on ESP microchip, and for the data storage SAMS data warehouse was used. The monitoring results showed that the choice of the location of the temperature sensor is important, as the temperature at the hive sides changes synchronously with the outside temperature. Also, feedback from the beekeeper is collected to further improve the system and monitoring process. This research is conducted within the SAMS – Smart Apiculture Management Services project, which is funded by the European Union within the H2020-ICT-39-2016-2017 call and with close collaboration with the local private beekeeper. To find out more, visit the project website https://sams-project.eu/.
Keywords: Precision beekeeping, SAMS, bee colony monitoring, temperature and weight monitoring.

Introduction

Asian honey bees, Apis Cerana (*A. cerana*), are honey bees from southern and south-eastern Asia with a variety of sub-species found in different Asian countries including Indonesia (Hyatt, 2012). Asian honey bee Apis Cerana is known for their gentle temperament and easy handling. To assess the colony strength, existence of pests, parasites and diseases beekeepers must open the hive and visually inspect it on a regular basis. (Brodschneider *et al.*, 2018, 2016; Delaplane, Van Der Steen, & Guzman-Novoa, 2013; Gray *et al.*, 2019; Van Der Zee *et al.*, 2012). However, manual monitoring of beehives is a time-consuming process for beekeepers and stressful to the bee colonies. Time-consumption even increases with the distance of the beekeeping sites to the homesteads, as bee colonies are frequently placed in rural areas, far from cities, in jungles or mountain areas, so every inspection also incurs travel costs to beekeepers.

To facilitate and improve the hive management procedure, the implementation of smart apiary management services is believed to be the future of modern beekeeping (Bencsik *et al.*, 2011; Edwards-Murphy *et al.*, 2015; Meikle & Holst, 2015; Zacepins *et al.*, 2016). For this approach, information communication and technology (ICT) based on remote sensing tools to monitor the bee colony's health and productivity are used (Zacepins *et al.*, 2015). While precision beekeeping approach is already widely used in Europe, the USA and other developed countries, it is concluded that in Indonesia, automated and remote bee colony monitoring is only on its starting point, and temperature, weight monitoring are not widely practiced. There are only few articles on the digital monitoring of Apis Cerana parameters. For example, some authors investigated the variances of the temperature, relative humidity and CO2 concentration among brood combs in the Apis cerana colony, by

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using the electric digital thermometer (Guanhuang *et al.*, 1999). Others conducted a systematic observation and research on the overwintering and size dynamic characters of Apis cerana in south and west mountainous area of Anhui Province in China in 1998-2003 (Yu & Han, 2003).

Based on temperature dynamics, different bee colony states can be identified (like swarming, brood rearing, broodless state). And based on bee colony weight dynamics, food consumption and amount of food storage can be evaluated and lack of resources can be predicted. For example, abnormal food consumption can indicate some unwanted behaviour of the bee colony. High food consumption during the passive period could indicate increased activity of the colony, possible brood rearing. Too early brood rearing is not always welcomed, as to the moment when the colony is strong, there could be insufficient foraging resources. In addition, bee colonies tend to abscond in Indonesia. Biological definition of the absconding comprises the departure of all adult bees of a colony from their nest, leaving behind whatever brood and stores are in it. Absconding may be due to shortage of food, disturbance, or to other adverse circumstances (Crane, 1990). Therefore, a remote monitoring system together with data analysis solutions can alert the beekeeper when the bees abscond.

This research is done within the SAMS project in collaboration with private Indonesian beekeeper. A combined biological, sociological and technical approach is made within the SAMS (Smart Apiculture Management Services) project. It enhances international cooperation of ICT and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". Main objectives of SAMS are to develop, refine and implement an open source remote sensing technology for monitoring the health and productivity of bee colonies and to foster the regional added benefit and gender equality in employment. The SAMS project focuses on beekeeping in Ethiopia (Demisew, 2016; Negash & Greiling, 2017; Wakjira & Alemayehu, 2019) and Indonesia (Gratzer *et al.*, 2019) as in those countries there is a huge beekeeping potential that is not fully discovered yet.

The aim of this study is to assess the feasibility of using precision beekeeping for bee colony temperature and weight monitoring of Apis Cerana in Indonesia, as well as to demonstrate that remote and automated monitoring of Apis Cerana is possible, and it can provide valuable information for the local beekeepers. This article presents the first results of measuring Apic Cerana temperature and weight during summer period.

Materials and Methods

Bee colonies

Since this study focuses on the evaluation and feasibility of the proposed monitoring system, only two bee colonies of Apis Cerana were subjected to experiments in the field. One bee colony is placed in a modern beehive (Figure 1).

The modern hive is made of wood with the outer size of 40cm length, 30cm width and 25cm height with wall thickness of 1,5cm. The second bee colony is placed in a frameless beehive which is also called "Golodog" with the same hive dimensions (Figure 2). Golodog type of modern beehives is actually a simple modern beehive that is used as a bee colony trap box. Beekeepers use this box to acquire new bee colonies and move the colony in the standard (with frames) modern beehive once the bee colony has settled, but sometimes they let the bee colony stay in this hive anyway.

Bee species under monitoring is Apis Cerana Cerana.

Location of the bee colonies

Experiment was carried out in an open environment at the private Madu Maribaya Apiary. This apiary

Figure 1. Modern beehive used in the experiment.

Figure 2. Frameless hive "Golodog".

is owned by Pak Koswara in Maribaya, West Java, Indonesia.

Status of the colonies

Based on the visual inspection of the hives, the beekeeper concludes that both colonies are in good condition. This is evaluated by the experience of the beekeeper by his own evaluation procedure. Procedure includes several basic actions: observation if the bees are still there, if the brood is present and the amount of it is sufficient, if the queen is present, and if the colony produce honey. In the case if all indicators are present, a conclusion about the bees condition can be made.

SAMS bee colony monitoring device

Two (2) bee colonies were equipped with a SAMS hive monitoring system based on the NodeMCU electronic platform (ESP8266 microchip) (Zacepins *et al.*, 2020), Figure 3.

For weight monitoring, a single-point load cell Bosche H30A was used. For the bee colony temperature monitoring DS18S20 1-Wire® sensors were used.

Architecture of the developed hardware platform is shown in Figure 4:

Temperature sensors were placed in three positions inside the hive: in the middle frame, in the most right frame and in the most left frame (Figure 5). Authors chose different sensor positions with the aim to compare the temperature dynamics and then conclude about the appropriate sensor position for the reliable temperature measurements.

Environmental conditions (temperature and humidity) were monitored using a DHT22 sensor. The NodeMCU platform were powered by a power bank. For the research purpose, data was collected each two (2) minutes and sent to the remote SAMS data warehouse. For internet connection, a mobile Huawei router was used, which was connected to the electric grid at the beekeeper's house. Distance from the router to the monitoring nodes is around 10m. As mobile connection at the apiary location was poor, interruption of Internet connection occurred and some data points were lost during the monitoring period, but this does not affect the overall conclusion making and monitoring process itself.

The first bee colony monitoring took place on 04.07.2020 and is still ongoing.

The second bee colony monitoring took place on 01.08.2020 and is still ongoing.

SAMS data warehouse

The SAMS Data Warehouse (DW) is a universal system, which can operate with different data inputs,

Figure 3. NodeMCU based hardware system.

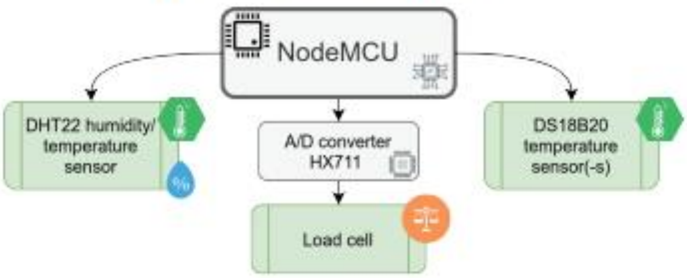

Figure 4. Hardware platform architecture.

Figure 5. Sensor placement in the modern beehive.

Figure 6. Summary of the bee colony data.

such as direct data transfer from bee colony monitoring devices as well as manual data upload, which has flexible data processing algorithms based on the incoming data sets. SAMS DW can be connected not only with SAMS monitoring devices, but also with other general available bee colony monitoring systems. The SAMS Data Warehouse is already developed and is a fully operational platform (https://sams.science.itf.llu.lv/). It can easily be accessed from any web browser. All measured data is stored in the SAMS DW for further analysis and report creation.

The screenshot below demonstrates how the summary of the colony monitoring is shown to the beekeeper in the SAMS DW in real-time (Figure 6):

Results and Discussion

Temperature monitoring

The performed monitoring results showed that the temperature measured by the sensors which were located at the sides of the hive changed synchronously with the outside temperature. This means that this location is not appropriate for the bee colony behaviour and state identification. This was also observed by other authors, but during the wintering period. Their results showed that the center temperature of overwintering bee flock changed synchronously with the outside temperature (Yu & Han, 2003).

The monitoring results showed that the temperature measured by the sensor located in the middle of the hive showed a stable temperature between 30°C and 35°C (Figure 7). This means that this location is appropriate for the bee colony behaviour and state identification. Observed temperature indicates that the bee colony is in an active state and makes brood (this state is also confirmed by the beekeeper visually observing the colony).

Temperature monitoring of the colony placed in the frameless hive also showed similar dynamics comparing to the colony placed in the modern hive (Figure 8). It means, that the basic remote monitoring of the bee colony is also possible for the frameless hives.

Weight monitoring

Load cell accuracy was verified in the lab during test measurements, comparing the acquired values with the known weight placed on the scales. It should be mentioned that during laboratory experiments with the developed platform, it is found that weight is fluctuating in relation to the environment temperature. When ambient temperature increases, weight of the hive decreases, and by decrease of ambient temperature weight increases. This can be explained by electronics used in the hardware platform and authors made a conclusion that A/D converter is affected by the temperature changes. It is concluded that by the change of the temperature to 1°C weight is changed up to 20g.

Figure 9 demonstrates the weight dynamics in Apis Cerana bee colony. It can be observed that during first days (taking into account weight correction) there is no increase in the colony weight. This means that the bee colony is able to forage resources needed only

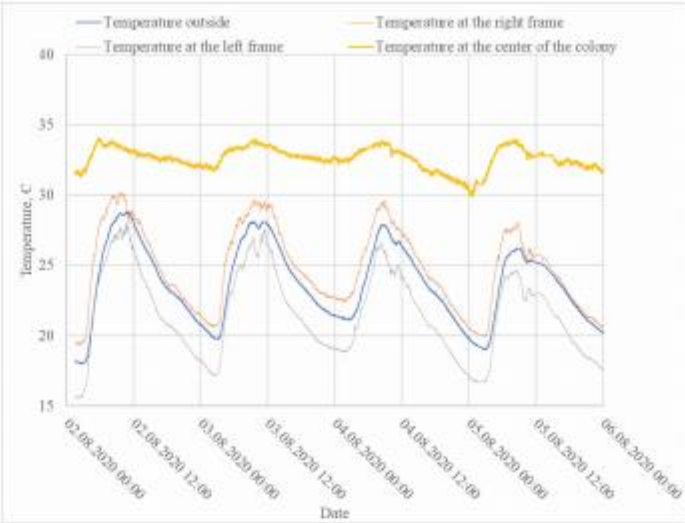

Figure 7. Temperature dynamics in the modern hive.

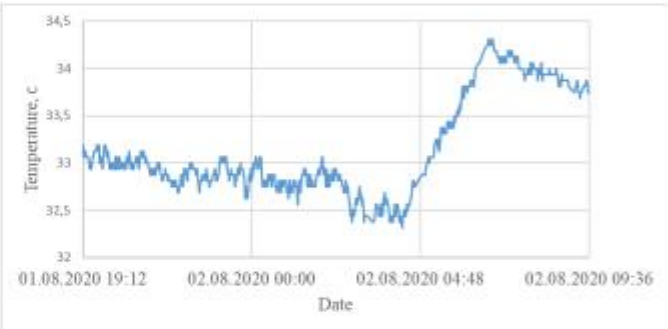

Figure 8. Temperature dynamics in the frameless hive.

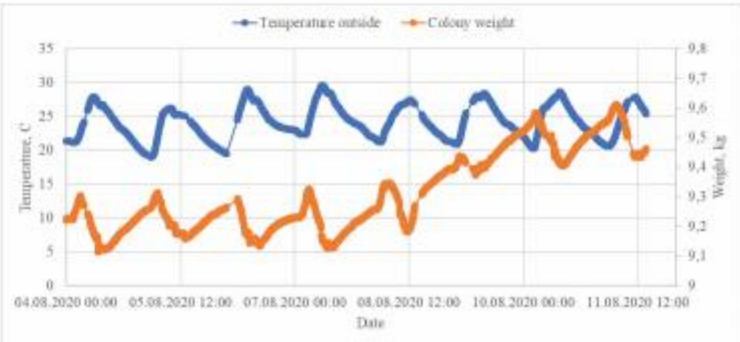

Figure 9. Weight dynamics of the colony.

for the colony survival. But then a slight increase in weight is observed.

Feedback from the beekeeper

During this study authors also collected a feedback from the private beekeeper about the developed monitoring system and collected data. Some key points addressed by the beekeeper are:

1. The system should be unseen from the outside and hardware parts should be hidden. This is needed to minimise the risk of possible theft.
2. The system installation process is very easy and the beekeeper can deploy the system itself without an assistance from the technical staff.
3. The beekeeper was impressed by the SAMS DW functionality and the possibility to remotely see how the colony is behaving.
4. Monitoring of only the bee colony temperature would not give a big benefit to a full-time beekeeper, rather this feature is mostly valuable if the beekeeper has other full-time jobs (or professions) and other family members help monitor the colony behaviour.

Conclusions

For the demonstration of the bee colony monitoring procedure in Indonesia, two bee colonies were equipped with the SAMS monitoring devices.

Installation of the precision beekeeping system in Indonesia allows to decrease the number of the visual on-site observations of the bee colonies and helps to detect abnormal behaviour of the colonies and could help to prevent death, absconding, colony collapse disorder (CCD) of the bee colonies.

One temperature sensor can be used for the remote bee colony monitoring. It is concluded that the sensor placement is important for the reliable bee colony temperature collection. The sensor should be placed in the middle of the hive near to the bee cluster, especially if the colony is a small one.

It is approved, that the temperature and weight monitoring can be used also for the frameless colonies, that are placed into simple bee colony trap boxes.

Implementation of the bee colony monitoring system to facilitate the development of the precision beekeeping in Indonesia is necessary and has an added value for the beekeepers, but still transfer of knowledge is needed to facilitate the understandability of the benefits provided by the remote bee colony monitoring systems, including the economic benefits for implementation of such systems.

In relation to the future work, there are several potential directions to work on:

- Monitoring of the Apis Cerana colonies during the whole year to identify the colony development phases;
- Improvement of the monitoring system and potential commercialisation of it;
- Adding additional functionality to the monitoring system, for instance, a solution to detect thefts, as it was mentioned by the beekeepers as important feature;
- Improvements to the developed data warehouse and implementation of analytics models.

References

Bencsik, M., Bencsik, J., Baxter, M., Lucian, A., Romieu, J., & Millet, M. (2011). Identification of the honey bee swarming process by analysing the time course of hive vibrations. Computers and Electronics in Agriculture, 76(1), 44–50. https://doi.org/10.1016/j.compag.2011.01.004

Brodschneider, R., Gray, A., Adjlane, N., Ballis, A., Brusbardis, V., Charrière, J.-D., … Danihlík, J. (2018). Multi-country loss rates of honey bee colonies during winter 2016/2017 from the COLOSS survey. Journal of Apicultural Research, 57(3), 452–457. https://doi.org/10.1080/00218839.2018.1460911

Brodschneider, R., Gray, A., van der Zee, R., Adjlane, N., Brusbardis, V., Charrière, J. D., … Woehl, S. (2016). Preliminary analysis of loss rates of honey bee colonies during winter 2015/16 from the COLOSS survey. Journal of Apicultural Research, 55(5), 375–378. https://doi.org/10.1080/00218839.2016.1260240

Crane, E. (1990). Bees and beekeeping: science, practice and world resources. Heinemann Newnes.

Delaplane, K. S., Van Der Steen, J., & Guzman-Novoa, E. (2013). Standard methods for estimating strength parameters of Apis mellifera colonies. Journal of Apicultural Research, Vol. 52. https://doi.org/10.3896/IBRA.1.52.1.03

Demisew, W. A. (2016). Beekeeping in Ethiopia: Country situation. ApiExpo Africa, 1–32.

Edwards-Murphy, F., Popovici, E., Whelan, P., & Magno, M. (2015). Development of an heterogeneous wireless sensor network for instrumentation and analysis of beehives. Conference Record - IEEE Instrumentation and Measurement Technology Conference, 2015-July, 346–351. https://doi.org/10.1109/I2MTC.2015.7151292

Gratzer, K., Susilo, F., Purnomo, D., Fiedler, S., & Brodschneider, R. (2019). Challenges for Beekeeping in Indonesia with Autochthonous and Introduced Bees. Bee World, 96(2), 40–44. https://doi.org/10.1080/0005772x.2019.1571211

Gray, A., Brodschneider, R., Adjlane, N., Ballis, A., Brusbardis, V., Charrière, J. D., … Soroker, V.

(2019). Loss rates of honey bee colonies during winter 2017/18 in 36 countries participating in the COLOSS survey, including effects of forage sources. Journal of Apicultural Research. https://doi.org/10.1080/00218839.2019.1615661

Guanhuang, Y., Dongjiang, S., Jingcheng, X., Qinghai, S., & Guilian, L. (1999). Study on the Regulation Ability of Apis cerana cerana on Temperature, Relative Humidity and CO2 Concentration in Its Colony. Scientia Agricultura Sinica, 03.

Hyatt, S. (2012). Asian Honey Bee (Apis cerana javana) in Cairns, Far North Queensland.

Meikle, W. G., & Holst, N. (2015). Application of continuous monitoring of honeybee colonies. Apidologie, 46(1), 10–22. https://doi.org/10.1007/s13592-014-0298-x

Negash, B., & Greiling, J. (2017). Quality Focused Apiculture Sector Value Chain Development in Ethiopia. Journal of Agricultural Science and Technology A, 7(2). https://doi.org/10.17265/2161-6256/2017.02.005

Van Der Zee, R., Pisa, L., Andonov, S., Brodschneider, R., Charrière, J. D., Chlebo, R., … Wilkins, S. (2012). Managed honey bee colony losses in Canada, China, Europe, Israel and Turkey, for the winters of 2008-9 and 2009-10. Journal of Apicultural Research, 51(1), 100–114. https://doi.org/10.3896/IBRA.1.51.1.12

Wakjira, K., & Alemayehu, G. (2019). Assessment of Colony Carrying Capacity and Factors Responsible for Low Production and Productivity of Beekeeping in Horro Guduru Wollega Zone of Oromia, Ethiopia. International Journal of Natural Resource Ecology and Management, 4(1), 14–21. https://doi.org/10.11648/j.ijnrem.20190401.13

Yu, L., & Han, S. (2003). Overwintering and size dynamic characters of Apis cerana cerana. The Journal of Applied Ecology, 14(5), 721–724.

Zacepins, A., Brusbardis, V., Meitalovs, J., & Stalidzans, E. (2015). Challenges in the development of Precision Beekeeping. Biosystems Engineering, 130, 60–71. https://doi.org/10.1016/j.biosystemseng.2014.12.001

Zacepins, A., Kviesis, A., Ahrendt, P., Richter, U., Tekin, S., & Durgun, M. (2016). Beekeeping in the future – smart apiary management. ICCC 2016, 808–812.

Zacepins, A., Kviesis, A., Komasilovs, V., & Muhammad, F. R. (2020). Monitoring System for Remote Bee Colony State Detection. Baltic J. Modern Computing, 8(3), 461–470.

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3. Upcoming SAMS Publications in 2021

3.1 20201 – Smart Apiculture Management Services for developing countries – the case of SAMS project in Ethiopia and Indonesia

Authors: Kibebew Wakjira, Taye Negera, Aleksejs Zacepins, Armands Kviesis, Vitalijs Komasilovs, Sascha Fiedler, Sascha Kirchner, Oliver Hensel, Dwi Purnomo, Marlis Nawawi, Amanda Manggiasih Paramita, Okie Fauzi Rachman, Aditya Pratama, Nur Al Faizah, Markos Lemma, Stefanie Schaedlich, Angela Zur, Magdalena Sperl, Katrin Proschek, Kristina Gratzer, Robert Brodschneider

Submitted to: PeerJ Computer Science

Reason for not being published during the project duration:

We received multiple reviews from the editor and decision to have a major revision. The manuscript was then adjusted according to the editor and reviewer suggestions. Afterwards the manuscript was re-submitted during the first half of December 2020. We are still waiting for the answer from the journal editor.

Short Abstract:

The European Union funded project SAMS (Smart Apiculture Management Services) enhances international cooperation of ICT (Information and Communication Technologies) and sustainable agriculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". The project consortium comprises four partners from Europe (two from Germany, Austria, and Latvia) and two partners each from Ethiopia and Indonesia. Beekeeping with small-scale operations provides perfect innovation labs for the demonstration and dissemination of cost-effective and easy-to-use open source ICT applications in developing countries. Within this frame SAMS allows active monitoring and remote sensing of bee colonies and beekeeping by developing an ICT solution supporting the management of bee health and bee productivity as well as a role model for effective international cooperation. By following the User Centred Design (UCD) approach SAMS addresses requirements of end-user communities on beekeeping in developing countries. And includes findings in its technological improvements and adaptation as well as in innovative services and business creation based on advanced ICT and remote sensing technologies. SAMS enhances the production of bee products, creates jobs (particularly youths/women), triggers investments, and establishes knowledge exchange through networks and initiated partnerships

3.2 2021 – Transition of Apis mellifera beekeeping in Ethiopia – from traditionalism to modern – a review. (Submitted to Agronomy of sustainable Development

Authors: Kristina Gratzer, Kibebew Wakjira, Sascha Fiedler, Robert Brodschneider

Submitted to: Agronomy for Sustainable Development

Reason for not being published during the project duration:

we submitted the manuscript to another journal at the end of September and waited several weeks for the editor's decision before we got rejected (topic was not suitable enough for the journal). In the same week, we submitted the manuscript to the journal mentioned above and ever since are waiting for the decision.

Short Abstract:

Ethiopia is one of the top ten honey and beeswax producers in the world but plays only a minor role in international honey trade. Beekeeping could generate sustainable income for rural poor, but the apicultural potential of the country has so far not been fully used. In this review article, we summarize the knowledge on Ethiopian beekeeping, honey bees, honey bee pests, marketing strategies, cultural aspects and major challenges of beekeeping. Further, we used FAOSTAT data to calculate a pollination gap to draw attention of stakeholders and decision makers to bees and their importance in pollination and sustainable rural development. A total of 590 bee forage plants and their flowering times were added as a supplement to the manuscript to provide a visibly attractive overview of Ethiopia's melliferous plants, which was not existing so far. This article is the first comprehensive review of beekeeping and bee research in Ethiopia. We hope, that the findings of this article, but also the knowledge gaps identified, help to increase the profile of apiculture and the research in Ethiopia.

3.3 2021 - SAMS - participatory development of smart apicultural management services in Ethiopia and Indonesia

Authors: Kristina Gratzer, Amanda M. Paramita, Katrin Proschek, Magdalena Sperl, Yosef Alemayehu, Robert Brodschneider

Submitted to: Proceedings of science

Reason for not being published during the project duration:

The organisers of the Citizen Science Conference 2020, UNIGRA attended, gave all people who had a talk, or a presented a poster at the conference the opportunity to publish a short manuscript in the Journal proceedings of science. Unfortunately, the timeline was changed after some issues between the organisers of the event and the publisher. The plan right now is to get published in mid of 2021

Short Abstract:

Honey bees can provide income for people in marginalized countries. Beekeeping creates jobs, has low starting costs, does not require own land and positively contributes to pollination of nearby areas, including farmland. Nevertheless, honey production is reported inefficient or below the production potential in many developing countries. The Smart Apiculture Management Services (SAMS) project aimed to improve the bee sectors of the target countries Ethiopia and Indonesia by creating a SAMS hive monitoring system, providing beekeeping training, contextualizing local systems and providing business

models. The User-Centred design approach guaranteed that the final SAMS products and solutions addressed the needs and requirements of beekeepers in the target countries. Within this article, three important UCD outcomes for the SAMS project are described: User centered design in the SAMS project, creation of personas to classify beekeeper characteristics, design and constructions of homes for bees. All (co-)created outcomes are freely available for everyone to use.

Project website: www.sams-project.eu

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