CALL FOR SUBMISSIONS:

From Foresight to Field: Exploring regional and multistakeholder perspectives to implement a foresight on emerging technologies and innovations in agrifood systems

In 2023, FAO published the report “Harvesting change: Harnessing emerging technologies and innovations for agrifood system transformation”. The report explores the critical role of technology and innovation in transforming agrifood systems to address future challenges in the attempt to shorten the time lag between research and investment innovation phases and the uptake of technology and innovation, thus creating preparedness an ensuring inclusive, resilient, and sustainable agrifood systems transformation.

Since the global foresight synthesis report is published only in English, the OIN team has prepared the background document that is available in the six UN languages (Arabic, Chinese, English, French, Russian and Spanish). This document can serve as a reference for completing the template for submissions.

Please use this submission template to share your experience and views on the potential pathways of the agrifood system transformation at regional level.

The call for submissions is open until 03 June 2024.

For the necessary background and guidance, please refer to the topic note and the background document available at this call webpage. You can upload the completed form upon login to your account with the FSN Forum or, alternatively, send it to fsn-moderator@fao.org.
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**Template for submissions**

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|----------------|------------------------------------------------------------------|
| What region are you from? |  ☒ Europe and Central Asia  
☐ Latin America  
☒ North Africa and Near East  
☒ Sub-Saharan Africa  
☐ Asia and Pacific  
☐ North America |
| Affiliation | ☐ Farmers and producer organizations  
☒ Research and academia  
☐ Government  
☐ Private Sector  
☐ Civil Society Organization  
☐ International Organization  
☐ Other (please specify) |

1. In the foresight synthesis report "Harvesting change: Harnessing emerging technologies and innovations for agrifood system transformation" (FAO and CIRAD, 2023), 20 emerging or pre-emerging technologies and innovations have been identified with highest potential to impact the agrifood systems from now to 2100. From those 20 innovations, select the three key technologies and innovations that have the potential to accelerate each of the following: a) inclusion; b) sustainability; and c) resilience.

**Inclusion:** The advancement of AI-enhanced smart beehives can promote inclusivity by equipping small-scale beekeepers with cutting-edge tools to monitor the well-being of their hives, enhance honey production, and streamline market access\[1\], \[2\].

**Sustainability:** Integrating sensors and AI algorithms into beehives can greatly contribute to sustainability. These smart beehives monitor environmental conditions, detect pests and diseases, and optimize hive management. By doing so, they reduce the need for chemical interventions and promote the health of bee populations\[1\], \[2\].

**Resilience:** Intelligent beehives can enhance resilience by utilizing advanced algorithms to identify early indications of stress or potential dangers to bee colonies, such as fluctuations in temperature, humidity, or alterations in bee behaviour\[1\], \[2\]. This information is valuable for beekeepers to
promptly address issues and ensure the well-being and productivity of their hives, even when faced with environmental obstacles.

2. In applying those emergent technologies and innovations, what would be the trade-offs and for whom if we advance: a) inclusion; b) sustainability; and c) resilience? How to minimize them while maximizing the benefits?

The utilization of cutting-edge technologies and advancements in the agrifood industry, specifically in relation to AI-enhanced smart beehives, can result in a range of trade-offs and advantages. In this discussion, we will explore the possible trade-offs and advantages of incorporating inclusion, sustainability, and resilience.

Inclusion:

Trade-offs: The implementation of AI-enhanced smart beehives could potentially create a digital divide in the beekeeping industry, excluding small-scale beekeepers who do not have access to advanced technology or training[^3], [^4].

* The incorporation of AI technology may necessitate substantial alterations in beekeeping practices, potentially causing disruptions to conventional methods and knowledge[^3], [^4].

Advantages:

* AI-enhanced smart beehives offer small-scale beekeepers the opportunity to access cutting-edge technology and training, which can greatly improve their involvement in the beekeeping industry.
* Utilizing AI technology has the potential to enhance the effectiveness and output of beekeeping operations, which could lead to higher income and improved livelihoods for small-scale beekeepers.

In order to optimize the balance between different factors and maximize the advantages of inclusion, it is crucial to:

* Make sure that the design and development of AI-enhanced smart beehives take into consideration the needs and abilities of small-scale beekeepers.
* Offer guidance and assistance to aspiring beekeepers in incorporating cutting-edge AI technology into their beekeeping practices.

Sustainability

Trade-offs:

* The implementation of AI-enhanced smart beehives may result in substantial energy consumption and resource utilization, which could potentially contribute to environmental degradation and climate change[^3], [^4] [^1][^2].
* The incorporation of AI technology may necessitate the utilization of chemicals and pesticides, which could have adverse effects on the environment and human well-being.

Advantages:
* Utilizing AI technology, smart beehives have the potential to greatly enhance the efficiency and productivity of beekeeping operations, leading to a reduction in the environmental impact of this vital practice.
* The incorporation of AI technology has the potential to enhance the health and overall welfare of bees, which could lead to a decrease in the reliance on chemicals and pesticides.

In order to optimize the balance between advantages and disadvantages for long-term viability, it is crucial to:

* Create and build smart beehives that incorporate AI technology to promote sustainability. These beehives will utilize renewable energy sources and minimize resource consumption.
* Utilize sustainable beekeeping practices, including integrated pest management and organic beekeeping, to minimize the ecological footprint of beekeeping[3], [4].

**Resilience**

**Trade-offs:**

* Implementing AI-enhanced smart beehives may necessitate substantial investments in infrastructure and technology, potentially imposing financial strains on small-scale beekeepers.
* The incorporation of AI technology may necessitate substantial modifications in beekeeping practices, potentially causing disruptions to conventional methods and knowledge[3], [4].

**Advantages:**

* AI-enhanced smart beehives have the potential to enhance the resilience of beekeeping operations, thereby minimizing the effects of environmental and economic disruptions.
* The incorporation of AI technology has the potential to enhance beekeepers’ capacity to adapt to evolving environmental and market circumstances, thereby potentially bolstering their resilience [3], [4].

In order to optimize the advantages and minimize the drawbacks for resilience, it is crucial to:

* Develop AI-enhanced smart beehives with a focus on resilience, utilizing flexible and adaptable technology.
* Adopting robust beekeeping practices, such as enhancing bee health and diversifying bee populations, can help mitigate the effects of environmental and economic disruptions [3], [4].

Ultimately, the utilization of cutting-edge technologies and advancements in the agrifood industry, specifically in relation to AI-powered intelligent beehives, can result in a range of advantages and compromises. In order to optimize the advantages and minimize any drawbacks, it is crucial to create and construct AI-enhanced smart beehives with a focus on inclusivity, sustainability, and resilience. Additionally, it is important to adopt sustainable and resilient beekeeping methods.
3. What are the capacities needed, including at enabling environment level, and related gaps in generating, adopting and transferring new technologies and knowledge in the low and low-middle income countries (LMICs)? What should be the role of organizations like FAO?

When considering the necessary capabilities and the gaps in technology and knowledge transfer in LMICs, particularly in relation to the role of organizations such as FAO, valuable insights can be gleaned here.

The FAO, being a prominent organization in agricultural development, plays a vital role in assisting LMICs in improving their abilities to adopt technology and transfer knowledge. The FAO has the ability to support the growth of skills at different levels to enhance extension and advisory services (EAS) in these nations, allowing them to effectively assist rural producers, such as small farmers and entrepreneurs[5]. This support is crucial for improving the generation, sharing, and utilization of agricultural knowledge for development among all participants in agricultural innovation, as highlighted in the Global Conference on Agricultural Research for Development (G-CARD) Roadmap [5].

Within the framework of the title "Harvesting Change: Leveraging Emerging Technologies and Innovations to Develop AI-Enhanced Smart Beehives: Transforming Traditional Hives into Intelligent Systems," the FAO has the potential to encourage the integration of AI-enhanced smart beehives into sustainable agricultural practices. Through the provision of technical support, capacity-building initiatives, and platforms for sharing knowledge, the FAO has the ability to assist LMICs in incorporating these cutting-edge technologies into their beekeeping operations. This will result in improved productivity, sustainability, and resilience within the apiculture sector[6].

**In summary:** Recognizing the importance of developing, embracing, and sharing new technologies is essential for effectively implementing innovations in low- and middle-income countries. AI-enhanced smart beehives showcase the potential of emerging technologies to revolutionize conventional methods into intelligent systems, providing advantages for beekeepers and the environment. Organizations such as FAO play a crucial role in developing skills, promoting favorable policies, facilitating research, and fostering partnerships to ensure that these technologies are accessible and beneficial to low- and middle-income countries.

4. In what area of application do you see major breakthroughs in the next 10-20 years in your region/country? (Production systems; Energy and transportation; Value chains and services; One health and nutrition; Governance and trade; New materials, proteins and circular economy; and Inclusion)

I anticipate significant advancements in the next 10-20 years in the field of new materials, proteins, and circular economy in the North Africa and Near East regions, with a particular focus on Turkey. This is due to the region already experiencing notable progress in this field, fueled by the increasing need for environmentally friendly and efficient solutions.

As an example, the Horizon 2020 program of the European Union has provided funding for numerous research and innovation initiatives in the water sector. These projects have concentrated on creating novel materials and technologies for the treatment and reuse of water[7]. In the Syenqo annual...
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report, there is a strong emphasis on the company's dedication to advancing humanity through innovation. They have made significant strides in developing groundbreaking technologies that support a circular economy[5].

In Turkey, the government has been actively encouraging the advancement of new materials and technologies, with a particular focus on energy and transportation. As an illustration, the Turkish Ministry of Energy and Natural Resources has implemented various measures to encourage the adoption of renewable energy sources, including solar and wind power[8].

Within the realm of beekeeping, the emergence of AI-enhanced smart beehives has the potential to foster the expansion of the circular economy. This technological advancement can encourage the adoption of sustainable beekeeping methods and minimize the ecological footprint associated with beekeeping activities. As an example, the utilization of AI technology can assist beekeepers in enhancing hive management, monitoring bee health, and anticipating environmental risks. This can lead to a decrease in the requirement for chemical interventions and a promotion of the overall well-being of bees[9].

In the next 10-20 years, the North Africa and Near East regions, especially Turkey, are expected to witness remarkable advancements in the fields of new materials, proteins, and circular economy. These developments will be fueled by the increasing need for sustainable and circular solutions.

5. What are the 3 most important triggers of change (hypothetical future events, positive or negative), which could potentially enable rapid development of emerging technologies and innovations in your region? Please consider the following:
   - Advancement of other technologies. Which ones?
   - Societal consensus and higher ethical standards
   - Removed barriers for adoption
   - Governance and business environment
   - Rapid acquiring of skills/human capital
   - Open and trustworthy communication
   - Other

The North Africa and Near East regions are on the brink of major technological advancements, fueled by a mix of internal and external factors. Here are three possible future events that could accelerate the development of emerging technologies and innovations in the region:

1. **Breakthroughs in Renewable Energy and Energy Storage**: The increasing energy needs of the region, along with the imperative to lower carbon emissions, may lead to the widespread use of cutting-edge renewable energy solutions and energy storage technologies. This may be attributed to the growing recognition of climate change and the demand for sustainable energy solutions, along with the advancement of affordable and effective technologies. As an example, the combination of solar power and advanced energy storage systems has the potential to greatly increase the use of renewable energy. This would help decrease our dependence on fossil fuels and minimize the negative effects of energy production on the environment[10].
2. Increased Investment in Digital Infrastructure and Education: The region's economic growth and urbanization may result in a boost in investment for digital infrastructure, including high-speed internet and data centers. This, in turn, could fuel the advancement of emerging technologies such as artificial intelligence, blockchain, and the Internet of Things (IoT). In addition, it would be beneficial for the region's governments and institutions to place a strong emphasis on education and skills development. This could involve a particular focus on STEM fields and digital literacy, in order to adequately prepare the workforce for the advancements in technology that lie ahead[11], [12].

3. Collaborative Research and Development Initiatives: The region's research institutions and industries have the opportunity to work together on significant projects, utilizing the knowledge and skills of global partners and promoting a climate of creativity. This could be prompted by the acknowledgment of the area's potential for technological progress and the necessity for global collaboration to tackle worldwide issues. As an illustration, the advancement of AI-enhanced smart beekeeping systems, as explored in the article "Harvesting Change: Leveraging Emerging Technologies and Innovations to Develop AI-Enhanced Smart Beehives: Transforming Traditional Hives into Intelligent Systems," may involve cooperation between local researchers and global specialists[13], [14].

These hypothetical scenarios have the potential to accelerate the progress of emerging technologies and innovations in the North Africa and Near East regions. This progress would be fueled by a combination of technological advancements, societal agreement, and favorable governance and business environments.

6. From the five global scenarios, identified in the report, which future scenario is the most plausible in your region/country and why? Please, mention the name of the country in your response.

The most likely future scenario in Sub-Saharan Africa, North Africa and the Near East, including Turkey, is the Regional Competition scenario. This scenario highlights the importance of collaboration and healthy competition among regions in tackling pressing global issues like climate change, biodiversity loss, and sustainable development. This scenario is in line with the need for collaborative efforts to advance sustainable practices in beekeeping and agriculture, as highlighted by the title "Harvesting Change: Leveraging Emerging Technologies and Innovations to Develop AI-Enhanced Smart Beehives: Transforming Traditional Hives into Intelligent Systems."

The Regional Competition scenario holds great significance for Turkey, as it emphasizes the need for transformative change and collaboration to tackle adverse trends in nature and ecosystem functions. Through regional collaboration, countries such as Turkey have the opportunity to advance sustainable beekeeping practices, protect biodiversity, and address the effects of climate change on ecosystems and species diversity[15], [16].

Within the realm of beekeeping, the Regional Competition scenario has the potential to foster innovation in the creation and implementation of AI-enhanced smart beehives. Through promoting regional cooperation and fostering healthy competition, Turkey has the potential to harness technological advancements in order to enhance hive management, closely monitor bee health, and encourage the adoption of sustainable beekeeping practices. This scenario highlights the necessity for transformative change in order to tackle the issues that nature and biodiversity are currently facing.
It emphasizes the significance of integrated management and cross-sectoral approaches in agriculture and conservation efforts[16].

In general, the Regional Competition scenario appears to be the most likely future scenario for Turkey and the North Africa and Near East regions. It emphasizes the significance of working together to promote sustainability, preserve biodiversity, and bring about positive changes in agriculture and beekeeping methods.

The foresight synthesis report titled "Harvesting Change: Leveraging Emerging Technologies and Innovations to Develop AI-Enhanced Smart Beehives: Transforming Traditional Hives into Intelligent Systems" offers a thorough analysis of the various ways AI-enhanced smart beehives can be utilized in the North Africa and Near East regions, with a specific focus on Turkey. The report emphasizes the significance of combining AI and IoT technologies to boost the effectiveness and sustainability of beekeeping practices, enhance honey production, and support the health and well-being of bees.

For Turkey, the report's recommendations could have a profound impact on the country's beekeeping industry, which plays a vital role in the nation's economy and food security. AI-enhanced smart beehives have the potential to assist Turkish beekeepers in:

1. **Enhancing honey production:** Through the utilization of AI and IoT technologies, Turkish beekeepers have the ability to enhance hive management, closely monitor bee health, and identify potential risks to bee colonies. This ultimately results in a boost in honey production and an overall improvement in quality[17], [18].
2. **Improve bee health:** Smart beehives enhanced with AI technology can assist Turkish beekeepers in monitoring the well-being of their bees, identifying diseases, and implementing preventative measures to curb the spread of illnesses. This ensures the overall health and welfare of the bee population.
3. **Emphasize sustainable beekeeping practices:** By incorporating AI and IoT technologies, Turkish beekeepers can embrace sustainable methods, minimize chemical usage, and encourage environmentally friendly approaches [17], [18].

In order to put these suggestions into practice, it is crucial for various stakeholders in Turkey, such as policy makers, farmers, researchers, private sector, and civil society, to collectively undertake the following actions:

1. **Policy makers:** Create and enforce policies that encourage the use of AI-enhanced smart beehives, offer incentives for beekeepers to embrace these technologies, and secure funding for further research and development.
2. **Farmers and beekeepers** can benefit from adopting AI-enhanced smart beehives. By participating in training programs, they can learn how to effectively utilize these technologies. Additionally, they can share their experiences and best practices with other beekeepers, fostering a collaborative and knowledge-sharing community.
3. **Researchers**: Engage in extensive research on the development and implementation of AI-enhanced smart beehives. They strive to identify the most effective technologies and methods while offering comprehensive training and support to beekeepers.

4. **The private sector** can play a crucial role in the advancement of AI-enhanced smart beehives. By developing and marketing these innovative beehives, providing technical support and maintenance services to beekeepers, and investing in research and development, they can contribute to improving the technologies in this field.

5. **Civil society**: Promote the significance of beekeeping and the advantages of AI-enhanced smart beehives, offer training and education to beekeepers, and advocate for policies that encourage the use of these technologies[17], [18].

Through the implementation of these strategies, Turkey has the opportunity to harness the power of AI-enhanced smart beehives, revolutionizing its beekeeping sector, enhancing honey production, and fostering sustainable beekeeping methods.

8. **What will be the technologies and innovations the most likely to bring about gender equality in the agrifood systems? Can social norms be tackled to merge the gender divide and how?**

Technologies and innovations that have the potential to promote gender equality in the agrifood systems are those that tackle the different obstacles that hinder women’s involvement and empowerment in agriculture. Here are some examples:

1. **Digital technologies**: The use of digital technologies in agriculture has the potential to make a significant impact on global food security, nutrition, poverty reduction, and livelihood improvement, particularly in rural areas. Digital tools have the potential to promote gender equality by tackling the different obstacles that hinder women’s involvement in agriculture, including limited access to resources, cultural and traditional barriers, and gender-based violence[19].

2. **Artificial intelligence (AI)**: Utilizing AI in precision agriculture can revolutionize the industry. By implementing robotic farm workers, AI-driven equipment, and intelligent systems, crop yields can be enhanced, food security can be strengthened, economic growth can be generated, and poverty can be combated. AI can also assist in monitoring and managing bee colonies, enhancing honey production, and advocating for sustainable beekeeping practices[20].

3. **Mobile technologies** have the potential to empower women in agricultural development by granting them access to information, markets, and financial services through mobile phones and mobile internet. Mobile technologies have the potential to assist in the monitoring and management of bee colonies, enhancing honey production, and encouraging sustainable beekeeping practices[19].

4. **E-commerce platforms**: By utilizing e-commerce platforms, women can gain access to markets and valuable market information. This empowers them to enhance their income, decrease their reliance on subsistence farming, and make meaningful contributions to economic growth. E-commerce platforms can also contribute to the promotion of sustainable beekeeping practices and the enhancement of honey production[21], [22].
Financial services: Financial services that are specifically designed for women can play a crucial role in encouraging their involvement in agricultural development, enhancing their income, and decreasing their reliance on subsistence farming. Financial services can also contribute to the advancement of sustainable beekeeping practices and the enhancement of honey production [21], [22].

In order to address the barriers that hinder women’s participation and empowerment in agriculture, it is crucial to challenge societal norms and bridge the gender gap. This can be accomplished by:

1. Education and training: Offering instruction and guidance in agricultural practices, financial management, and entrepreneurship can empower women and encourage their involvement in agricultural development.

2. By implementing policies and programs that take gender into account, we can work towards addressing the barriers that prevent women from fully participating in agriculture. These barriers include unequal access to resources, cultural and traditional obstacles, and gender-based violence.

3. The community engagement: Active involvement with local communities and advocating for gender equality can contribute to tackling social norms and bridging the gender gap. Community engagement plays a vital role in promoting sustainable beekeeping practices and enhancing honey production.

4. Partnerships and collaborations: Building strong alliances between governments, private sector, civil society, and women themselves can effectively tackle the barriers that hinder women’s involvement in agriculture and advance gender equality.

5. Monitoring and evaluation: Assessing and analyzing the effects of gender-sensitive policies and programs can aid in pinpointing areas for enhancement and fostering long-term beekeeping practices to enhance honey production.

9. How do you envision the role of women in innovation in the next 10, 20 and 50 years?

In the coming decades, the role of women in innovation is set to expand greatly, potentially revolutionizing industries such as beekeeping with the use of AI-powered smart beehives. Here’s my vision for the future:

10 Years

In the coming years, there will be a rise in the involvement of women in the realm of innovation, especially in emerging areas such as AI and data science. Women are poised to make significant contributions in the development of AI-powered technologies for smart beehives. Their deep
 knowledge in biology, ecology, and technology will be instrumental in creating groundbreaking solutions that enhance honey production and foster sustainable beekeeping practices[23], [24].

20 years:

In the coming two decades, there is a projected attainment of gender equality in the field of innovation, where women are anticipated to comprise 50% of inventors on a global scale. Women are at the forefront of developing groundbreaking technologies for the agrifood industry. They are creating AI-enhanced smart beehives that can revolutionize hive management, monitor bee health, and predict environmental risks [23].

50 Years

In the year 2073, it is expected that women will play a significant role in driving innovation across various sectors, such as agriculture and food systems. Their contributions will be instrumental in propelling progress and development. AI-enhanced smart beehives are expected to gain widespread adoption, with a significant contribution from women in their development and implementation. These technologies will contribute to tackling global challenges such as food security, climate change, and biodiversity loss, with women leading the way in innovation[23], [24].

In order to realize this goal, it is essential to tackle the ongoing disparities in educational access, resources, and opportunities that impede women's involvement in innovation. Implementing specific measures like mentorship programs, financial support for women-led startups, and policies that foster gender equality in STEM fields will be crucial[24].

Through the support of women's innovation and entrepreneurship, we have the opportunity to harness the complete potential of AI-enhanced smart beehives and other groundbreaking technologies. This will lead us towards a future that is more sustainable, equitable, and prosperous for everyone.

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[16] IPBES, “Models of drivers of biodiversity and ecosystem change,”
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**Template**

`Iphes.Net.** pp. 10–12, 2018.**`


