Task Force 2
Climate Change, Sustainable Energy & Environment

Policy brief

PROMOTING SUSTAINABLE AGRICULTURE IN SMART CITIES

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ABSTRACT

This brief elaborates on the development of sustainable agriculture in smart cities, addressing the challenges related to increasing demand for protein-rich food due to intense urbanisation. It considers development of the appropriate technologies and optimised infrastructure required for the massive uptake of smart urban farming and simultaneously enabling circular economy mechanisms for recycling waste into value assets. Data collection, storage and analytics are expected to play a seminal role for smart farming applications, therefore it will be important to ensure wide network connectivity, efficient Big Data architectures, data privacy and security.

CHALLENGE

Intense urbanisation is expected to lead to large megacities that will have increased demand for food, which – combined with rising income levels – will result in shifting the global diet towards high value animal proteins and meat-based ready meals.

FAO findings indicate that the world is not going to meet most of the food and agriculture-related SDG targets by 2030 (FAO 2020). Food insecurity is still rising, affecting currently around 26% percent of the global population. The resulting increase in food demand highlights the need for innovative agricultural models. The exponential growth in food demand is amplified by the following factors (Broom 2020): (a) dietary changes leading to the consumption of processed, meat and dairy products, (b) changes in arable lands due to desertification caused by global warming as well as increasing water scarcity, which may lead to the loss of nearly 50% of current farm productivity by 2050, and (c) reduction of farmer populations due to urbanisation, as well as large-scale over-farming and soil degradation practices that mainly affect small family businesses and communities.

This trend simultaneously increases percentages of obesity-related diseases for the general population and increases pressure on livestock farming production, which has a substantial Greenhouse Gas footprint and excessive energy and water resource requirements.

The heavy dependence of (mainly urban) diets on staple grains, animal sourced products, oils, salt and sugar leads to the rise of obesity-related diseases especially in lower income classes, which consume inexpensive products containing excessive calories and low in nutritional content (UN/FAO 2020).

Additionally, current Agriculture and Livestock practices are responsible for generating around 20% of total GHG emissions, mainly due to methane, which is considered to be much more potent than CO_2 in contributing to global warming (Henderson 2020).

Therefore, there is strong interest in pursuing more efficient and sustainable agricultural production models and mechanisms, as well as in shifting the focus towards alternative protein sources such as those developed in aquaculture or the cultured meat industry.

It has been reported (Henderson 2020) that ruminant meat protein sources such as beef and lamb are the most GHG intensive, as compared to poultry and fish. The biggest source of agricultural emissions – almost 70% – is from the production of ruminant meat such as beef and lamb, which is much more GHG intensive in comparison to poultry, fish or legume products. Aquaculture is a promising field of agriculture for filling the animal-based protein gap and for improving the population's average diet and health. The related land use requirements are comparable to those of the poultry industry (Searchinger 2019), and its low GHG emissions as well as its related high ROI can provide the conditions for sustainable business growth.

Additionally, the domain of Smart Agriculture is gaining momentum as it combines technological innovations in the areas of Precision Farming Robotics, 3D Farming, Wireless Sensor Networks, Internet of Fixed and Mobile Things, Data Science, Big Data Analytics and Artificial Intelligence in order to maximise crop efficiency and livestock productivity without wasting natural resources and simultaneously enabling circular economy models.

PROPOSAL

POLICY RECOMMENDATIONS

There are solutions to address the challenges mentioned above by promoting smart city development models and combining technological evolution and effective governance that can lead to improvements in the quality of life and in the sustainable use of resources (Al Dabbagh 2020).

The objective of the proposal is to highlight key policies promoting key domains related to sustainable farming techniques in combination with smart city mechanisms to achieve food security, increased productivity, minimum natural resource requirements, recyclable waste and minimum GHG footprint, minimising impact on the environment and biodiversity.

Key Policy: Enhance the food security of urban environments by promoting sustainable agriculture, adopting circular economy models and healthy shifts in the context of smart cities, by leveraging key technological enablers and infrastructure.

The transformation of agriculture involves shifting the key production sites closer to or within cities, leading to the Urban Farming Trend, integrating green spots within cities, roof-top gardens, as well as vertical 3D farms. These concepts can lead to sustainable solutions, providing direct access to food products, enhancing food security against problems caused by extreme weather events, transportation and supply chain disruptions such as those caused by COVID-19 related mobility restrictions, and can also bring citizens closer to fresh and organically produced food, addressing issues caused by the reported fragility of the global food system (Restrepo 2020), especially during the occurrence of critical global events such as the current pandemic. Vertical farms enable the growth of food in vertically stacked layers and can operate in challenging environments, using soil, hydroponic, or aeroponic methods, requiring much less water, fertiliser, nutritional supplements, and nearly no pesticides. Since they mainly rely on artificial lighting, however, cost effective vertical farming is dependent on having access to affordable electricity (De Clercq 2018). There are already many examples of projects that can combine various innovative and energy efficient technologies to optimise production with minimum carbon footprint. Vertical Farming can provide sustainable solutions, especially in the case of MENA countries, where conditions for conventional farming are not favourable due to large areas of desert land and low rainfall rates (Banerjee 2014), and can provide profitable and successful models for innovative food production (Avgoustaki 2020).

Furthermore, G20 Leaders have been committed to tackling the challenges in food security and nutrition, and reinforcing the efficiency, resilience and sustainability of food and agriculture supply-chains (G20 2020a).

G20 countries should promote the concepts of Urban Farming and the development of the relevant technological enablers, along with the appropriate training of scientific personnel and farming specialists to enable the wide deployment of such smart agriculture methods.

G20 countries should also support public-private partnerships and motivate SME companies to participate in the business ecosystem. Furthermore, G20 countries should incentivise the development of urban farming by appropriately regulating land usage within cities, and offering energy subsidies and other tax incentives, or by subsidising the use of renewable energy sources, in order to minimise the carbon footprint. Furthermore, there should be incentives for developing the whole value chain around urban farming sites, enabling easy access to fresh, healthy organic food at low prices, minimising the footprint of food production and food waste and optimising the farm-to-fork paths.

The agricultural sector needs to address the abovementioned challenges by employing key business and digital transformation steps, focusing on both the demand side as well as the value chain/supply side, utilising technological tools and opportunities, addressing the market requirements and appropriately modifying the whole value chain. Technology enablers are related to low cost and sophisticated machinery that can employ artificial intelligence and robotic functionalities for performing on the field tasks with much more precision and efficiency. This is also enabled by the multiple connectivity options that can be provided by advanced Internet of Things and Wireless Network technologies using either licensed or unlicensed frequency bands. In that way it will be possible to transform farming sites of various sizes and types into automated production zones adopting a similar evolutionary transformation path as other industries, following the principles of Industry 4.0. Another technical enabler is related to the introduction of Digital Twins concepts that can provide personalised curation of complex agriculture processes, quantification of uncertainties, streamlining of operations and human-centred intelligence (Pylianidis 2021).

Even though there are no commonly agreed frameworks for the transformation of agriculture and for the optimised and sustainable use of resources (Chicoma 2020), it is important for all related stakeholders to make use of the available opportunities across the food value chain, exploiting new technological and scientific solutions within the framework of “Farm to Fork” Strategy targeting appropriate enabling policies. The EU is heading in that direction by promoting sustainable practices, such as precision agriculture, organic farming, agroecology, agroforestry and stricter animal welfare standards (European Commission 2019). Indicative examples of related innovative technology tools and solutions include the use of robots for precision farming or livestock breeding tasks, massive wireless sensor networks reporting environment measurements such as temperature and humidity, aerial drone networks that can provide accurate representation of crops and farm land status, etc. These innovative technologies can enhance the quality of information collected from the various sensing devices which in turn can be used for predictive analysis and intelligent decision making, and can optimise the use of high precision actuation machinery, reducing the dependence on large amounts of water, fertilisers and pesticides across entire fields, leading to cleaner organically grown products.

G20 countries should promote the Digital Transformation of Agriculture using the new technological enablers that provide fine grained data-rich analysis of the various stages of agricultural production across the end-to-end food value chain. Research and Innovation should be appropriately promoted on a global scale. Also, it will be important to assist small and medium sized businesses to embrace new technologies by providing appropriate financial incentives and subsidies that will allow the wide uptake of Industry 4.0 technologies in agriculture. This policy action can lead to the development of key use cases that are related to urban farming and can be an integral element of Smart Cities.

It will be important for smart farming networks to have resilient connectivity to 5G+ broadband wireless networks and Internet of Things to generate vast amounts of information and data (measurements, observations and metadata) that should be protected from any privacy and security threats. Data collection, storage and analytics will be of great importance for smart farming applications, therefore care should be taken to ensure Wireless Network connectivity, efficient Big Data architectures, data privacy and security.

Key threats are related to ransomware, endpoint attacks, phishing, third party attacks, supply chain attacks, artificial intelligence and Machine Learning-driven attacks, crypto-jacking, cyber physical attacks, state sponsored attacks, IoT attacks, threats to smart devices and attacks on connected, semi-autonomous or autonomous, vehicles (Demestichas 2020). Additionally, Smart Agriculture has to address challenges related to the physical security of the IoT equipment that is spread across wide areas; also, Big Data in agriculture include sensitive information concerning the infrastructure, machinery and production, therefore appropriate security and confidentiality measures have to be considered and software/hardware interoperability has to be standardised (Friha 2021).

The G20 is aligned with the 2030 Agenda for Sustainable Development for promoting strategies that can bring fundamental changes in developing infrastructure and services in various sectors affecting citizens' everyday lives and emphasise the critical role of secure and trusted data flows, wireless connectivity and human-centred approaches to Artificial Intelligence technologies (G20 2020b).

G20 countries should enable the development of digital data-centric and information-centric technologies that will transform agriculture. Emphasis should be given to developing the required wireless and wireline network infrastructure that will enable the wide deployment of broadband and massive Internet of Things networks as well as to the deployment of interoperable Big Data systems for efficient information collection, transport and processing in order to drive smart applications utilising Predictive Analytics and Artificial Intelligence. This should be performed by also ensuring that key principles of data security, trust and privacy are respected in order to protect citizens, businesses and governments from cybersecurity risks.

In addition, over the last two centuries the global economy has been operating in a linear manner, based on the take-make-waste model that accelerated the parallel forces of resource extraction and consumer demand without considering the effects on the availability of natural resources and the environment. Even in recent years, the global calls for environmental awareness and sustainability have not changed human dependence on the linear economy. According to De Wit, in 2020 the global economy was characterised as 8.6% circular (De Wit 2020), whereas in 2018 this indicator was higher (9.1%). This widening of the circular economy gap has been attributed to high rates of extraction, ongoing stock build-up and increasing (but still low) levels of end-of-use processing and cycling.

In order to make the tectonic shift towards a circular economy there is a need for transformative solutions, such as sustainable agriculture practices, food waste reduction and waste to value transformation. This will require the adoption of innovative technologies promoting planet-friendly resource utilisation, towards sustainable and climate-friendly goals (Muscio 2020), entailing a shift from "necessity" (efficient use of resources, and rational waste management) to "opportunity" (design products to make what is currently a waste become a resource for a new production cycle and create value).

According to Henderson, around 30% of the world's food output is wasted during production or consumption (Henderson 2020). This percentage should drop to 20% by 2050, according to the plan for reducing global temperatures by 1.5°C by then. Waste reduction can also indirectly decrease the GHG emissions related to the production, transport and refrigeration of wasted food as well as those emissions related to food decomposition.

In that spirit, the 2020 G20 Riyadh Summit Leaders' Declaration endorsed the Circular Carbon Economy platform and its "4Rs" framework (Reduce, Reuse, Recycle and Remove), highlighting the importance of enhancing environmental sustainability (G20 2020a), (G20 2020b), with applications also in agriculture.

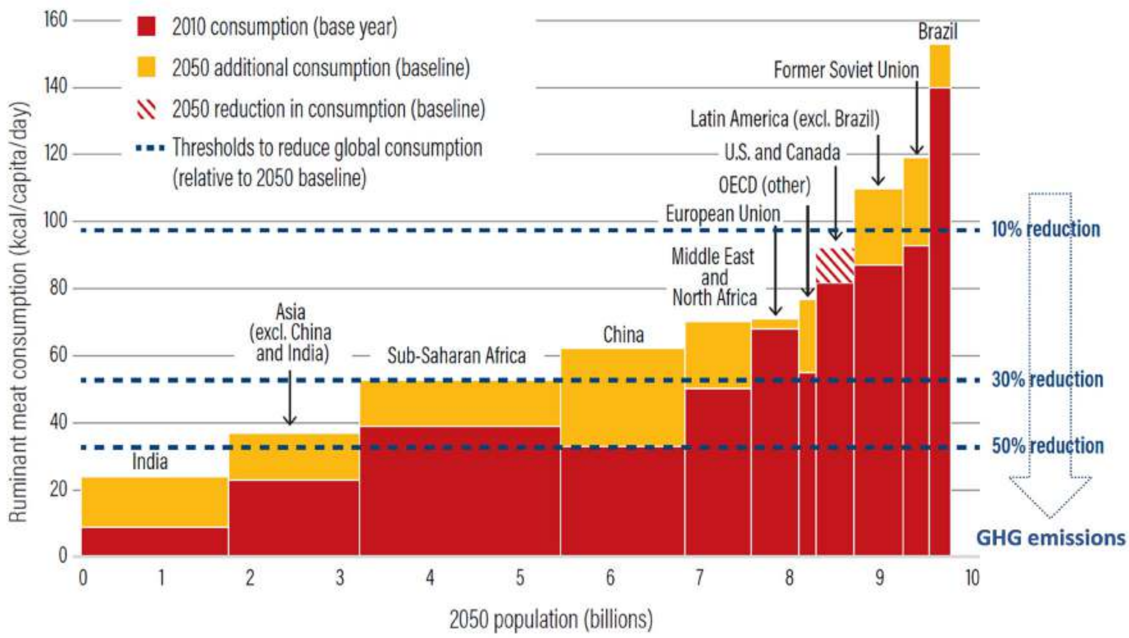
This complex transition requires intensive research in the agri-food sector to unravel the links between the complexity of food systems and their efficiency, resilience and sustainability, which governments must promote and sustain. The real transition will depend on financing specific agri-food projects, on the circular economy as well as on motivating innovation not strictly for technology development but also as a means for a real socio-technical transition.

Finally, policies should encourage a shift towards reducing the share of ruminant animal protein in the global protein-consumption mix, in order to promote the production of other sources of protein that have lower GHG emission requirements during production, leading to more environmentally sustainable solutions. The effect of decreasing the daily per capita consumption of ruminant meat in all regions on GHG emissions is illustrated in Figure 1.

That also involves companies making strategic choices to shift their focus towards more sustainable products and to get out ahead of their customers' preferences and habits, forcing them in a way to adapt their diets in response (Davis-Peccoud 2020).

Fig. 1 - Decreasing the daily per capita consumption of ruminant meat in all regions may lead to substantial reduction of GHG emissions

(Searchinger 2019)



It should be noted that the Aquaculture industry (farmed fish and seafood) generates a smaller carbon footprint than conventional meat production and is gaining increasing support from the EU – with focused Research and Innovation Calls – as a means for sustainable organic farming, enhancing future global food security (European Commission 2020).

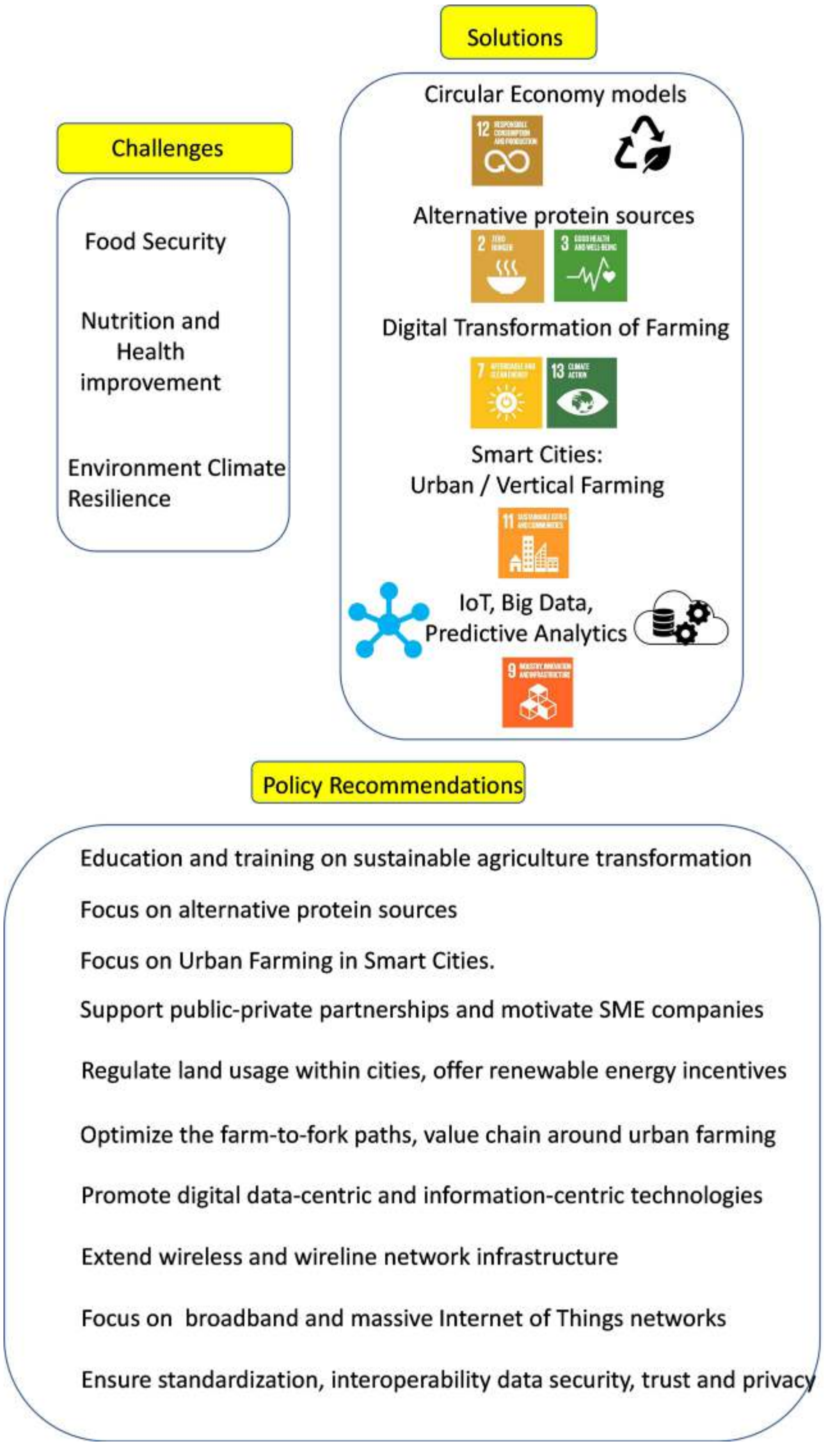
The G20 should motivate global investments in research and development on meat substitutes such as plant-based meats, blended meat-plant products and aquaculture products to achieve their market viability and customer acceptance against traditional meat-based products.

This also involves an orchestrated marketing and education campaign on alternative protein sources for improving dietary habits towards plant-based foods and plant-rich dishes, to stimulate behavioural changes.

Additionally, the role of the G20 in motivating pricing strategies and retail-level taxes on meat products is very important, in order to promote alternative protein products and to provide incentives to businesses for switching their focus towards such products (Searchinger 2019).

Figure 2 depicts the proposed Policy Framework which can be considered as a basis for the G20 to motivate the creation of interdisciplinary task forces. This framework can assist in developing a roadmap for the digital transformation of agriculture in smart cities and thus in generating useful governance guidelines for the implementation of the aforementioned policy recommendations.

Fig. 2 - Proposed Policy Recommendation Framework



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