

Controlled Environment Agriculture for sustainable development: A call for investment and innovation



Controlled Environment Agriculture (CEA) is the production of plants, fish, insects or animals inside structures, such as greenhouses and buildings, in controlled conditions. In a rapidly urbanizing world, CEA can contribute to sustainable development, e.g. through reduced use of land, water and inputs. There is a need for innovation in policy, technology and business practices to scale up CEA in the Global South sustainably and equitably.

Photo: Chaminda Ranasinghe

Actions needed

- **Grant-making bodies, NGOs and commercial financial institutions should develop dedicated CEA agribusiness/agripreneur programs**, including innovative debt financing.
- **Economic agencies should invest in development of supply chains to support CEA**, including growing media, equipment and seeds, and post-harvest infrastructure such as cold storage, through – for example – business support and mentoring, business incubators and tax breaks.
- **Regional and national governments should form public-private partnerships (PPPs) for the development of regional CEA clusters or tech hubs**, enabling growers to share experiences, innovations and information, leverage economies of scale, and market collectively.
- **National and local governments should acknowledge CEA as a viable form of agriculture and design policy innovations to promote the sector**, including in agriculture development policy; land use and planning policy; economic development and employment plans; and import regulations.
- **Technology developers should dedicate R&D spend to trialing their inventions with growers in low and lower-middle income countries**, to ensure they are optimized for these contexts and to provide access to new, environmentally safe, developments as early as possible.

The challenge: CEA needs to be a force for sustainable and equitable development

CEA is one of the most intensive farming systems. The ability to optimize inputs and produce high yields of vegetables and protein in a confined and often artificial environment is of considerable interest in the context of the environmental and climate emergency, and as rapid urbanization places land and resources under pressure. High-tech vertical farms in urban areas of industrialized countries have attracted significant investment to date, but there is nascent activity in Africa and Asia too, especially small- and medium-scale operations using low-energy techniques, local materials and minimal water.

While every proposed CEA installation should be thoroughly assessed for its suitability and viability in the local context and potential impacts, hydroponics and aquaponics may support food security and nutrition by enabling production in inhospitable locations, including urban areas, and locations facing land and water access issues. The possibility of producing crops year round can support economic access to food by removing price fluctuations. Black soldier fly farming shows promise for circular waste management, while producing two marketable outputs: compost and protein for animal feed.

Widespread uptake of several forms of CEA, and scale-up or replication of existing operations, can bring economic opportunities – either through job creation or, with proper support, entrepreneurship. As a less labor-intensive and more ‘white collar’ form of farming than open field agriculture, CEA attracts a new generation of farmers with strong IT skills.

Despite the potential, would-be practitioners face significant barriers to entry and successful practice of CEA. These include high start-up costs; lack of training (in schools, universities and at the professional level); lack of tailored extension services; poor access to inputs and post-harvest services due to lack of value chains; inaccessibility or unaffordability of the latest technologies; and the absence of CEA from the policy agenda, resulting in zoning and regulations that do not take account of CEA as a form of urban agriculture.

If unaddressed, these barriers will result in a wasted opportunity to develop CEA as a viable, complementary form of agriculture in countries that face significant challenges, and to support equitable livelihoods, food and nutrition security, sustainable resource use and environmental stewardship.

Remove entry barriers, especially for disadvantaged youth and women

For CEA to be a viable option for people from less affluent backgrounds, financial institutions including banks, micro-finance institutions and parastatal agricultural finance agencies should invest in people as well as equipment by designing innovative debt financing models for entry-level, small-scale CEA practitioners. These may include:

- Provision of equipment to set up operations, as well as provision of welfare and living costs over an initial period, so that new starters can cover everyday expenses
- A payback period that is customized to CEA growing cycles with repayments beginning after the activity starts to be profitable
- In cases of contract farming, three-party agreements between lenders, borrowers and buyers, with the latter guaranteeing a market for the borrowers’ produce.

Grant-making bodies, NGOs and commercial financial institutions that work in Africa and Asia should promote research and innovation through dedicated CEA agribusiness/agripreneur programs and incubators under their agricultural development programs. These may include preferential grant or loan schemes that are tailored to the needs of women, young people and applicants from disadvantaged social groups.

Opening CEA to people from a range of backgrounds and socio-economic groups will promote poverty reduction and provision of viable livelihoods for people who currently lack economic opportunities.

In addition, locally appropriate CEA techniques should be included in educational programs at all levels, from elementary school to agricultural universities. The installation of demonstration gardens could provide produce for the local community, as well as enable students to develop valuable STEM (science, technology, engineering and math) skills, and increase the pool of potential employees for CEA businesses as they scale up, expand or replicate in new locations.

Bring organization, knowledge exchange and practical support to CEA practitioners

The self-organization of CEA practitioners into associations or cooperatives (local, regional or national), if necessary with help from development organizations and NGOs, can enable peer-to-peer support, facilitate value-chain development (ensuring availability of inputs and equipment), and allow practitioners to collectively identify their needs and lobby their governments to address them. It can also optimize their access to investors who are unable to deal with individuals.

Organization may also be formal, through PPPs for the development of regional CEA clusters or tech hubs where growers can work collectively or in close proximity, sharing experiences and information (e.g. on optimal technologies or disease management), leveraging economies of scale on equipment and inputs, and marketing collectively. Clusters require significant investment in infrastructure (structures, electricity, water, etc.), innovative mechanisms to make public or private land available, and incentives for growers to move to the area (tax reduction for initial periods, business support, etc.).

Another formal support mechanism is the provision of CEA training by agriculture departments, tailored to specific local needs, regularly updated to include emerging technologies so that the latest knowledge reaches people in low and lower-middle income countries.

Agricultural extension services should ensure agents are knowledgeable in CEA techniques so they can identify problems post-setup and know how to help. New, innovative extension models may also be developed to facilitate knowledge exchange between early adopters and extension officers, as well as formalize direct peer-to-peer exchange between early adopters and new starters.

Collectivity and dedicated support mechanisms will benefit individual CEA practitioners by helping them to overcome operational hurdles and reducing the risk of failure. These mechanisms will stimulate development of the sector as a whole, from vertical farms in slums to high-tech container or rooftop farming.

Create an enabling policy and regulatory environment

At the local level, zoning ordinances and urban agriculture regulations should include specifications on CEA so that there is clarity on what is permitted and where. CEA may also be integrated into spatial design and building codes.

At the national and regional levels, governments can create an enabling environment for CEA adoption and mainstreaming through policy innovations in several areas. For example:

- Agricultural policy can advance mainstreaming of CEA, through funding provision and extension capacity
- Food security and nutrition strategies can recognize the contribution of CEA, especially for ensuring local supply that is less vulnerable to disruptions and promoting year-round stable prices
- Employment strategies may recognize and promote employment opportunities in CEA, including the need to develop suitable skillsets for all supply chain roles
- Land use policy can acknowledge CEA as a legitimate activity, removing any barriers to land access accordingly.

In addition, national governments should develop evidence-based industry standards and regulations, through cooperation between relevant government departments, the private sector and NGOs to ensure they are conducive, relevant and appropriate. These will enable farmers to plan their activities and support a good reputation for the sector. Early development of standards and regulations will pre-emptively discourage harmful or fraudulent practices and help to avoid excessive or punitive regulations in the future.

Regulatory standards on the nutrients required in hydroponic growing should be used as a reference for customs inspections to avoid unwarranted import bans or tariff inconsistency. The removal of several regulatory barriers to CEA in a concerted, integrated way will create an enabling environment for practitioners to operate close to urban markets and access inputs, training, extension support and human resources.

Develop sustainable, accessible CEA technologies for low and lower-middle income contexts

There is a need for ongoing research into CEA techniques to minimize energy consumption and costs, and reduce use of synthetic or environmentally unfriendly inputs, while optimizing efficiency. As optimal techniques will vary depending on local context, such research should be carried out by local and/or international universities and agricultural research centers in partnership with local CEA growers, and funded by public institutions.

The inclusion of CEA in the official overseas trade and development programs of (high income) countries with strong CEA sectors is an innovation that would encourage private CEA companies and technology developers to invest in new (low and lower-middle income) markets, where their solutions can be adapted and adopted to suit the local contexts. This may include dedication of R&D spend to trials of new inventions by African and Asian practitioners to ensure they meet their needs and environmental regulations, and to provide access to new developments as early as possible (especially equipment to monitor or survey crops, and equipment for post-harvest processing and cold storage to reduce food waste and environmental footprint).

Where equipment costs cannot be reduced to be immediately affordable by small-scale producers in Africa and Asia, technology companies could help by devising hire-purchase schemes that would enable operators of limited means to access equipment immediately.

Conclusions

CEA is not a silver bullet for food security or agri-food system sustainability or equity. It is unlikely to replace open field agriculture, nor render urban areas self-sufficient in fresh produce, but as a form of urban

farming it has potential to complement rural systems' ability to deliver fresh produce and niche commodities, for both low-end and high-end customers. With increased awareness, innovative forms of targeted investment, and supportive policies, the application of optimal, appropriate CEA techniques in each context can transform livelihoods and environmental outcomes and contribute to urban diets.

Huge technological advances on how to grow food close to consumers, where land is in short supply and conditions are inhospitable, must be made available to communities that stand most to benefit from them.

A small but growing number of entrepreneurs are taking up CEA in urban and peri-urban areas across Africa and Asia. These pioneers often learn techniques by watching YouTube videos and apply them using a trial-and-error approach. They are generous with their knowledge, running free or affordable training courses and building their own communities of practitioners from the ground up. These pioneers, their protégés, and the sector as a whole would benefit from the concerted efforts of multiple actors to remove entry barriers and ensure operational viability of CEA, and to promote CEA cultivation of local crops that are accessible and affordable to all.



Salad cucumber (Photo: Chaminda Ranasinghe)

For more information, see the full report at: <https://hdl.handle.net/10568/117234>



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