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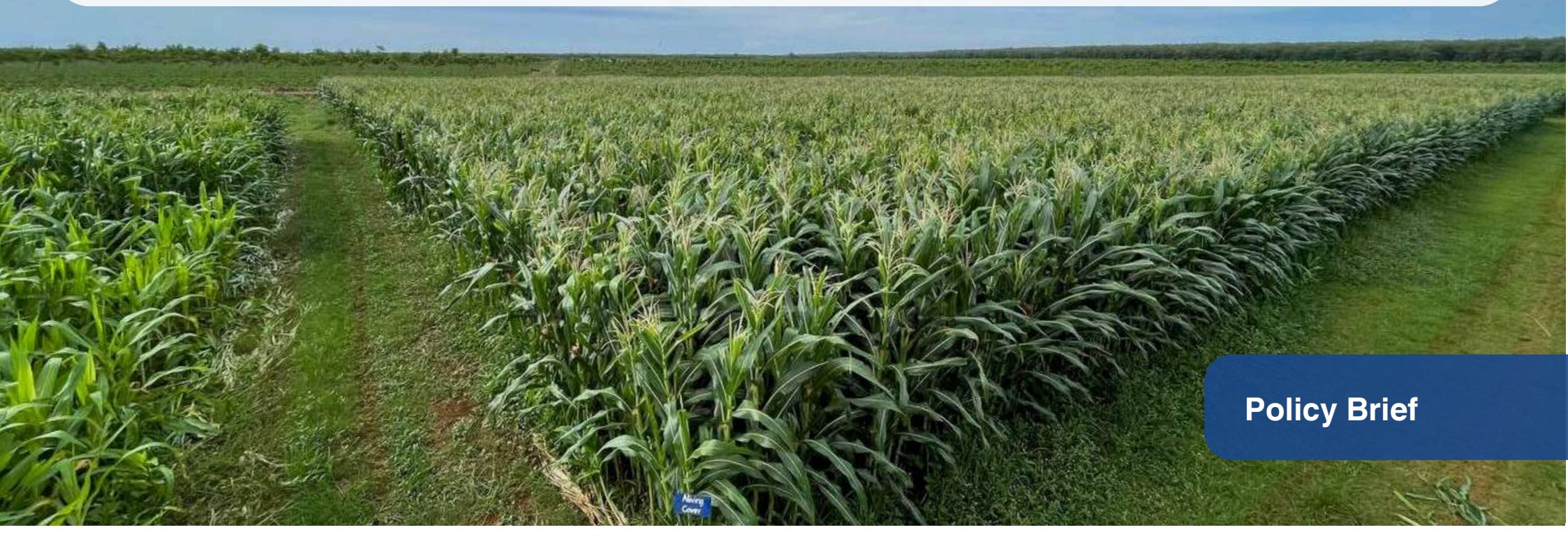
Agroecology and Safe Food System Transitions



Policy Brief

SUSTAINABLE MAIZE PRODUCTION: THE POTENTIAL OF CONSERVATION AGRICULTURE

KEY MESSAGES

- Land degradation is a national crisis in Cambodia the costs of which are estimated at almost 700 million USD per year. Inaction is not an option as it would severely endanger national food security and sovereignty.
- The benefits of conservation agriculture have been proven over the past 20 years: better soil health, soil carbon accumulation, GHG mitigation, higher yields, more income, and use of agrochemicals that does not interfere with, or disrupt, biological processes.
- Conservation agriculture is key for sustainable intensification. When combined with quality seeds, agroecological pest control, integrated nutrient, and weed and water management, it promotes timely operations and improves overall land management.
- Maize production is a key sector to promote conservation agriculture as it includes around 11% of rural households, and conventional maize production is responsible for a substantial share of the soil fertility depletion and land degradation problems.
- National government can help to overcome the barriers of conservation agriculture adoption, such as high initial investment costs, lack of engagement of the private sector, and poor access to appropriate technology.

LAND DEGRADATION: A NATIONAL CRISIS IN CAMBODIA

In Cambodia almost half the soils are degraded and more than half of the population resides in degraded areas. The environmental, economic, and social implications of this crisis are massive: topsoil is being washed away at rates ranging from 0.33 to more than 80 tons per hectare and per year, depending on soil type and slope (CARDI, 2016). Rice and maize yields on depleted soils are 15 to 30 % below their potential, forcing farmers to spend more on fertiliser or clear more forest – and thus accelerate greenhouse-gas emissions – to compensate for the lower yields. According to the UNCCD (2018), land degradation costs Cambodia approximately USD 677 million annually. Without large-scale restoration and adoption of soil-conserving practices, these losses will deepen, jeopardising Cambodia's agricultural growth targets, its Land Degradation Neutrality pledge for 2030, and rural livelihoods.

LAND DEGRADATION: THE ROLE OF MAIZE

Maize is one of Cambodia's dominant market-oriented upland crops. In 2024-25, maize harvest is estimated at a record 1.7 million tons produced on 270,000 hectares, an area that has doubled since 2001. Surveys suggest that maize is grown by 11 % of rural households in the western production belt. Their numbers tripled between 2007 and 2017 as cash-crop opportunities expanded.

At the same time maize is intricately linked to the land degradation crisis: In many parts of Cambodia, maize farmers continue to rely heavily on conventional plough-based tillage, which is characterized by soil disturbance, limited soil cover, and the predominance of monoculture. While these practices may offer short-term gains in productivity, they contribute significantly to soil degradation, run-off and soil erosion, and declining soil fertility. Remote-sensing studies attribute 2/3 of all forest loss in north-west Cambodia over the past 15 years to smallholder maize- and cassava-driven expansion.

BOX 1

What is Conservation Agriculture (CA)?

Principles: CA is grounded in three practices: **(1) minimal soil disturbance, (2) permanent soil cover using cover crops or crop residues, and (3) crop diversification.** These practices enhance soil health, increase organic matter, reduce erosion, and improve water use efficiency (Séguy et al., 2006)

Origins: CA begun in the USA in the 1930s and spread to South America in the 1970s. It was adapted to tropical areas in the Brazilian savannah in the 1990s and has since spread to other regions worldwide. Recent data indicates that it is practiced on 180 million ha or about 12.5% of arable land worldwide, mostly in Latin, Northern America and Asia (Kassam et al., 2019).

Key benefits:

- **Soil Organic Carbon (SOC)**: Field studies in northwestern Cambodia demonstrate that maize-based CA systems, especially those involving no-till and legume cover crops, can increase SOC by 0.3 to 0.5 t/ha/year over a five-year period; this rate ranges from 0.60 to 1.47 t/ha/year for the red Oxisol (Leng et al., 2024).
- **Soil health**: Soil biodiversity indicators (earthworm population and beneficial insect presence) can increase by 30 to 50% under CA. These improvements enhance soil functions, leading to better water retention and nutrient cycling (Pheap et al., 2019).
- **Yields**: In on-farm trials, CA practices led to a 10 to 20% increase in maize yields compared to conventional tillage systems, while reducing input costs related to fuel, fertilizer, and erosion control.
- **Income**: Farmers adopting CA report income gains of up to $150 – $300 per hectare annually, thanks to reduced labour input for land preparation and reduced inputs of pesticides and synthetic fertilizers. Additionally, farmers can generate income by producing and selling cover crop seeds.

CONSERVATION AGRICULTURE HELPS

Conservation Agriculture (CA) offers a sustainable alternative by reducing soil disturbance and maintaining ground cover (see text boxes 1 and 2). Numerous studies have demonstrated that maize grown under CA gradually improves in performance compared to conventional methods, yielding higher gross profits while requiring lower inputs of agrochemicals. Therefore, promoting CA in maize cultivation not only enhances environmental resilience but also offers clear economic benefits to farmers.

By prioritizing land-restoration and degradation-prevention efforts in maize-growing zones, it is possible to address a leading cause of soil erosion, fertility loss, and deforestation while reaching many farmers and safeguarding large areas of farmland. Targeting CA efforts at the maize sector offers rapid, demonstrable wins for farmers, and fits seamlessly with national soil-health, climate and extension policies. Success here will create both the evidence, and the service infrastructure needed to extend CA to other crops.

Sunnhemp is grown during off-season to increase soil fertility.

OPTIONS FOR POLICY

Although past programmes often focused on yields, national frameworks (National Action Plan to Combat Land Degradation, NDC, Agriculture Development Sector Program) already stress soil conservation. The main challenge is implementation and scale. Here are key priorities and options for policy:

ADDRESS ADOPTION BARRIERS

Several barriers to the adoption of CA remain (see Text Box 3). A priority for the government will be to help overcome these barriers to adoption through targeted support for last-mile access to seeds and cover crops, basic machinery and services, and practical, locally adapted CA packages, backed by peer learning and simple incentives.

SUPPORT PARTNERSHIPS

Enhanced collaboration between national institutions is key to promote the adoption of CA. The Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of Environment (MoE) are key actors to promote collaboration and partnerships among actors. Together, they can encourage stakeholders across sectors to participate in promoting CA practices. Existing governmental initiatives include CASIC (see Text Box 2).

REALLOCATE RESOURCES

Reallocate resources, including government funding, material support, and substantial investment in technical resources and machinery suitable for CA implementation. With increasing labour scarcity in the agricultural sector, CA systems must enhance labour productivity. The MetKasekor initiative addresses this challenge (see Text Box 2).

PROMOTE BIODIVERSITY

The performance of CA systems is contingent upon the level of diversification of the cropping systems and the quantity and diversity of biomass produced and restored to the soil. Facilitating access to a wider range of plant species is essential for sustaining soil health and crop diversification and generating new income. Initiatives promoting this include CARDEC/DALRM and the Crop Seed Department of the General Directorate of Agriculture (GDA) (see Text Box 2).

BUILD CAPACITY

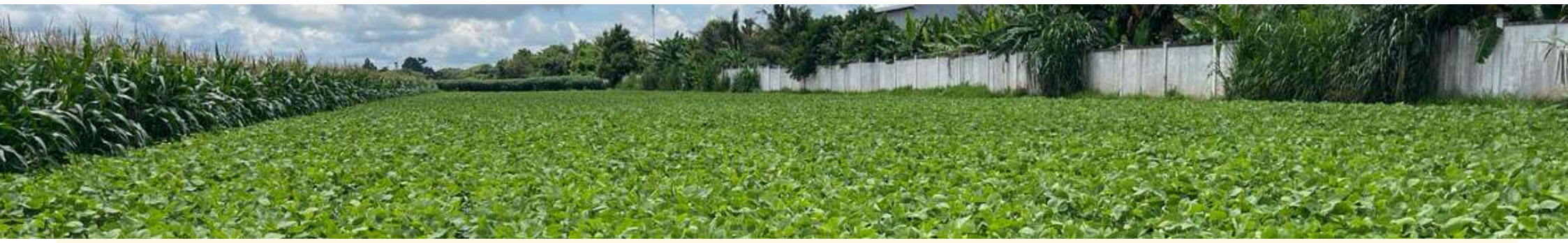
Strengthen extension and local service providers to empower farmers, cooperatives and contractors. Focus training on design, operation, and troubleshooting of CA systems rather than short awareness events. This will empower farmers, agricultural cooperatives, service providers, and water user communities who play a key role in the design, promotion, and practical implementation of CA systems. The Soil Doctor Programme supports this aim (See Text Box 2).

ASSESS IMPACT

Consolidate existing studies to better understand the economic benefits of CA. This concerns mainly its ability to enhance land and labour productivity, soil biological functioning, soil organic carbon accumulation, water infiltration rate, and nutrient cycling. Medium to long term on-farm monitoring will provide scientific evidence to inform policy.

FINANCIAL INCENTIVES

Financial incentives to encourage the transition to CA systems. Incentives can be practice-based (e.g. the SRP for rice), impact-based (e.g. carbon credits and co-benefits, such as social and environmental benefits), or loans with reduced interest rates. However, carbon market and others financial mechanisms should be seen as a tool and not as an objective to cover the cost of transitioning to CA. Aggregating several mechanisms enables farmers and operators to transition smoothly.



BOX 2

Conservation Agriculture Initiatives in Cambodia

In Cambodia, CA was initiated in 2004 as a research project supported by the French Development Agency, the General Directorate of Rubber, and CIRAD at Bos Khnor, Kampong Cham. From 2008 to 2012, two projects led by the Department of Agricultural Land Resources Management (DALRM/GDA) designed a range of CA-based cropping systems and studied the effect of CA on soil organic carbon and other soil ecosystem services. In 2010, a USAID funded project piloted CA extension on annual crops and vegetables in Battambang Province. Since 2020, CA efforts focus on policy dialogue and cross-sectoral networking. . There are several CA initiatives in Cambodia:

- **CASIC** (Conservation Agriculture and Sustainable Intensification Consortium): Was launched by MAFF in 2020. Coordinates national CA and sustainable intensification programs (www.casiccambodia.net). CASIC establishes links between six ministries (Agriculture, Forestry and Fisheries; Environment; Water Resources and Meteorology; Women's Affairs; Education, Youth and Sports; and the Interior Ministry), the Cambodian Chamber of Commerce, and the Council for Agricultural and Rural Development (CARD), which is responsible for the food systems roadmap.

- **Soil Doctor Programme**: Implemented by the Department of Agricultural Land Resources Management (DALRM) of GDA. The programme increases awareness and encourages the search for alternatives to improve soil management.

- **CARDEC/DALRM** (Conservation Agriculture Research and Development Centre of the Department of Agricultural Land Resources Management): designs a range of CA-based cropping systems for annual rainfed crops and rice, maintains a cover-crop gene bank with over 45 species and more than 200 cultivars to guarantee the integrity and quality of genetic materials, and to disseminate them to farmer communities and the private sector. CARDEC leads research on CA systems for maize, cassava, and soybean. Since 2014, direct seed drills are promoted in Battambang Province, giving farmers access to this service and showing that CA services can be commercially viable.

CARDEC Conservation Agriculture Fields in Bos Khnor, Kampong Cham.

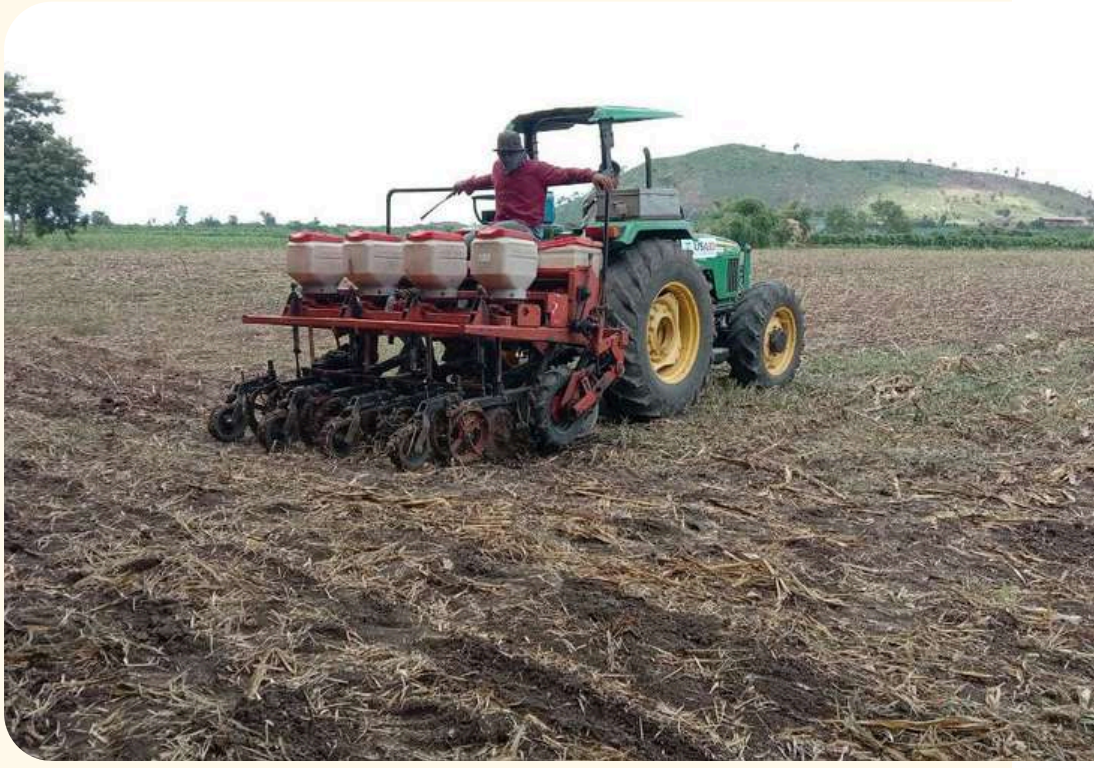
- **MetKasekor:** the initiative facilitates collaboration between manufacturers, local workshops, service providers (individuals and agricultural cooperatives), and farmers. The objective of this public–private partnership initiative is to align supply and demand, thereby generating new economic opportunities. The initiative works through the Department of extension of MAFF and the PDAFF (www.metkasekor.org).

BOX 3

Barriers to Adoption

Despite the demonstrated benefits of CA, several barriers limit its wider adoption:

1. **Investment Costs:** CA systems require significant upfront capital. Expenses include cover crop seeds, specialized planting and soil cover equipment, and field modifications. In comparison, conventional tillage has lower initial investment costs, but long-term degradation risks.
2. **Access to Tools and Infrastructure**: There is a limited availability of CA-appropriate machinery and tools, particularly in new implementation zones or extension target areas. Despite promising initiatives (i.e., Metkasekor), there is still also a lack of support from national manufacturers and local workshops to produce or repair CA equipment.
3. **Institutional and Technical Support**: There is insufficient technical assistance and limited institutional capacity to support farmer training, exchanges between agricultural communities, follow-up, and monitoring. Extension services often lack knowledge or mandates related to CA. The newly established Commune Agriculture Officers (CAOs) and modernized agricultural communities (MAC) could be the driver for a larger scale dissemination of CA practices.



A no-till planter is deployed on a field in Battambang's Ratanak Mondol District.

4. **Private Sector Engagement**: Agro-dealers, equipment suppliers, and input providers still show low engagement in promoting or supplying CA technologies. Absence of a viable CA value chain hinders input-output market linkages and service provision.

FURTHER READING

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