ENHANCING CLIMATE RESILIENCE THROUGH INTEGRATED ENERGY, AGRICULTURE, AND WATER MODELLING

KEY RECOMMENDATIONS

- **Support with policy and economic incentives the sustainable mechanization of agricultural practices** instead of expanding agricultural land. By increasing irrigation to 45.5% and mechanization to 96% of the harvested land by 2055, Lao PDR can provide an additional 420,000 tonnes of rice per year while saving 8,000 km^2 of land, contributing to Lao PDR's NDC conditional target of 70% land cover, supporting the Green Growth Strategy's afforestation goals, and ensuring long-term food security.
- **Plan water and energy infrastructure in parallel with afforestation targets,** because the mechanization will result in a 51% rise in water needed for irrigation and 34% rise in power needed for irrigation by 2055. The additional power demand can be met through a minimal increase of both solar (2.98 TWh or +1.2% relative to the baseline over the modelling period) and wind generation (1.86 TWh or +2.5%), accompanied by a decrease in hydropower generation (−0.36 TWh or −0.05%). Deploying efficient pumping systems is critical to manage rising irrigation needs amid constrained land availability.
- **Support the shift to more climate-resilient rainfed rice varieties** such as nationally developed *thadokkham* varieties (the name of a locally produced rice variety), where TD11 (one of the subvarieties), in particular in the north, appear to have the lowest cost (−25%) compared to the old mix.

SUMMARY

There is a need for integrated land use, energy and water supply planning to achieve Laos' Green Growth Strategy afforestation targets while ensuring food security under climate change. The least-cost pathway for achieving the afforestation targets is the mechanization of agriculture via high-input farming that covers 52% of small-scale and 44% of commercial-scale production of nine main crops by 2055. This increases the use of surface water resources (by 51% per year compared to the baseline scenario) and of electricity for irrigation (by 0.64 TWh in 2055), highlighting the need for infrastructure planning and for diversification of electricity supply, to ensure security of supply under climate variability. Further, emerging and available climate-resilient, rainfed rice varieties can lower the overall cost of rice production by 17% and water use for rice production by 21% in the north by increasing the yields of low-input, rainfed rice crops by 114%.

CONTEXT: SUPPORTING LAND USE PLANNING FROM AN INTEGRATED PERSPECTIVE

The agricultural sector of Lao PDR faces rising challenges due to limited irrigation coverage, climate variability, and fragmented planning. The expansion of cash crops such as cassava and maize has intensified the pressure on land resources while increasing demands on water and energy systems. New irrigation schemes and agro-industrial zones are reshaping landscapes and competing with forests, conservation areas, and hydropower catchments. In many regions, yields remain low and productivity could be improved through sustainable intensification rather than further land clearing—which would only put at risk achieving Laos' Green Growth Strategy's afforestation target.

Electricity use for agriculture is expected to grow in the coming decades as demand for irrigation, crop processing, and mechanization increase. Meeting this demand will require distributed electricity access and connections to national power grid, as emphasised in the National Power developed Plan and the Lao PDR Nationally Determined Contribution (2021 Update).

We used the Climate, Land, Energy, and Water systems (CLEWs) modeling framework to answer two policy-relevant questions and unveil potential opportunities from increasingly integrated planning on land use, water, energy supply and agricultural in Lao PDR.

1. The development and mechanization of agriculture can support the achievement of the afforestation target of Lao PDR's Green Growth Strategy

Achieving 70% forest cover by 2030, as outlined in the National Green Growth Strategy and the Land Use Master Plan, can be realized through mechanized agriculture and

irrigation, which lead to 7.8% average increase of the yields. However, the increase of mechanized and irrigated agriculture, which would triple between 2021 and 2055, also leads to a large increase in water use for irrigation (from around 1.2 billion m3 in 2021 to more than 1.8 billion m^3 by 2055) and electricity use for pumping water (from about 0.83 TWh in 2021 to nearly 2 TWh by 2055). While this does not exceed the renewable freshwater resource limits, the trend can lead to increased pressure on localised water resources, unless efficient irrigation infrastructure and integrated water resource management are put in place.

2. New climate-resilient crops can improve food security without significantly compromising land resource use

We tested the productivity and competitiveness of TDK11, a climate-resilient rainfed rice variety used in small-scale production that has reduced cost and proven higher yield than other varieties. This new variety finds the best growing conditions in the north, where it is deployed on 5,900 km^2 by 2055 (if afforestation targets are not taken into account), leading to an increase of agricultural land in that region compensated by a decrease in the centre and south. This shift leads to a decrease in water use for agriculture to more sustainable amounts (from 1.2 billion m^3 in the baseline to 0.7 billion m^3 in the smart-agriculture scenario by 2055), with an accompanying reduction in the electricity used for irrigation. Moreover, thanks to a 114% increase in the yields of low input rainfed rice crops from TDK11, the overall rice crop cost decreases by 25% in 2055, compared to the baseline. The introduction of the new crop thus emerges as an excellent opportunity for increased climate resilience and productivity at lower economic and resource cost.

WAY FORWARD

The coordination between institutions in charge of agriculture, water resources, energy, environment, and land planning could be enhanced by creating a dedicated interministerial CLEWs working group, or by incorporating CLEWs analysis as a recurring agenda item into an already existing working group, in support of coherent resource planning that prevents siloed decision-making. The institutionalization of CLEWs modelling in national planning frameworks can support updates to the Agriculture Development Strategy, the National Green Growth Strategy, the National Adaptation Plan, and future revisions of the Land Use Master Plan and the Nationally Determined Contributions to the United Nations Framework Convention on Climate Change. There is also a need to invest in local capacity for data collection and organisation, modelling, and scenario development in support of CLEWs analysis in the interministerial working group.

Figure 1

Total harvested area for rice per region

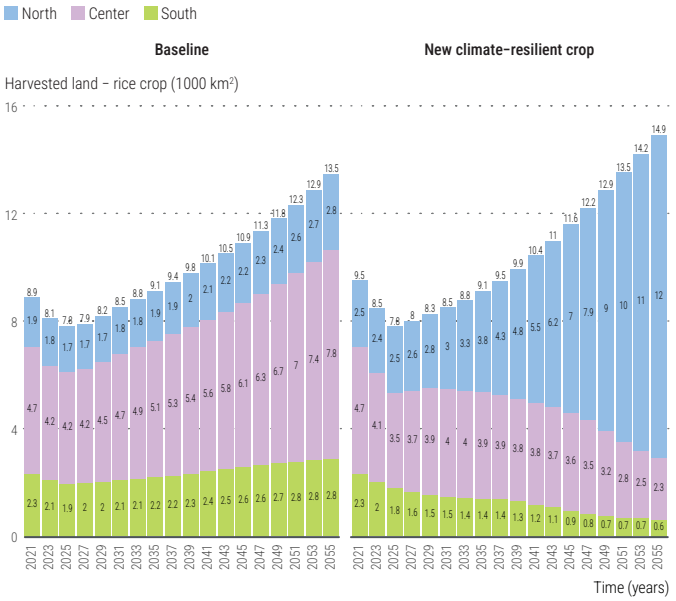
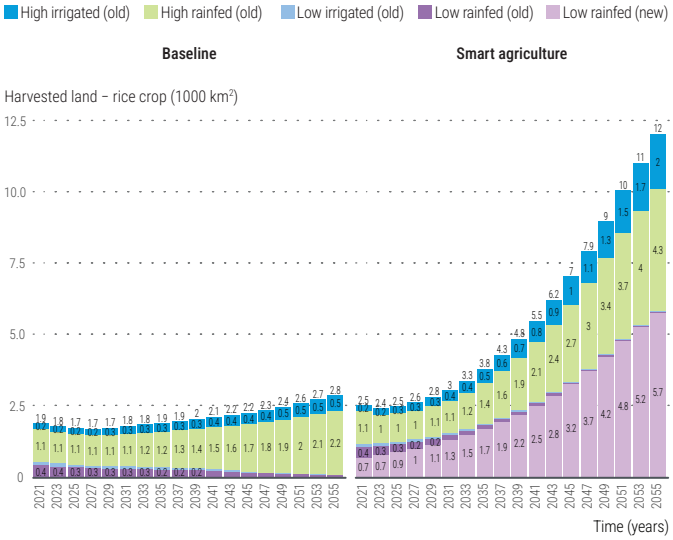


Figure 2

Harvested area for rice in the north region—old crop mix (old) and new resilient crop (new) by input level (high/low) and irrigation method (rainfed/irrigated)



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