



Food and Agriculture Organization
of the United Nations



EXPLORING CASSAVA FUTURES

BUILDING CASSAVA
CLIMATE RESILIENT
PATHWAYS **IN LAO PDR**



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RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



Utrecht
University

STORYMAP HIGHLIGHTS



Elaborated by the authors.

SCOPE & OUTLINE

Cassava (*Manihot esculenta*) is a drought-tolerant that is grown in tropical and subtropical areas. It is a staple crop and an important raw material and valuable food source for producing starch, bioethanol and other bio-based products (e.g. feed, medicine, cosmetics and biopolymers). In Lao PDR, the crop is cultivated by many smallholders, mainly ethnic groups living in remote mountainous areas. Cassava can grow well in almost any soil type and is often cultivated using traditional farming practices, based on subsistence farming and labor intensive techniques. The market demand is high from investors of both domestic and foreign parties such as China, Vietnam and Thailand. The national government of Lao PDR promotes farmers for commodity production in order to eradicate the poverty of people.

Although cassava is expected to be a relatively climate-resilient crop, the production of cassava comes with a wide variety of consequences for agricultural land and natural resources, both for short and long term. Examples of problems are low soil quality caused by soil degradation and erosion, unstable yields, use of pesticides, natural hazards induced by climate change (flood, drought), destruction of forest area, land conflicts among farmers and land owners, and difficulties in managing and

monitoring private sectors and government agencies. In this “story map”, the cassava production system is analyzed using the output of the Strengthening Agro-climatic Monitoring and Information Systems Agro-Ecological Zoning future crop suitability maps and multiple foresight analysis tools. All elements of the cassava value chain are identified, as well as current and future risks and opportunities. Based on these analyses, policy recommendations containing proposed actions and strategies are imposed in the form of a pathway action plan. This is done in order to ensure an effective implementation of the Agriculture Development Strategy (ADS) 2025 and the vision of the agriculture sector to the year 2030. This document aims at “ensuring food security, producing comparative and competitive potential agricultural commodities, developing clean, safe and sustainable agriculture and shift gradually to the modernization of a resilient and productive agriculture economy, linking with rural development contributing to the national economic basis”. Achieving these goals requires all partners both at the central and local levels including farmers to pay attention, enhance the coordination and collaboration needed for consistency and strong support. This story map is a crucial tool for policy markers and other stakeholders involved in cassava production.

As stated in the ADS 2025 and the 9th national socio-economic development plan of the government for the years 2021-2025, cassava production is aimed to be increased to a total area of 108,460 ha and a production of 3,6 million ton/year. In 2019, the total area was 67,726 ha, with a production of 2,26 million ton.

The geopolitical boundary in this analysis is on national level.

The key themes in this document are:

- Identification of suitable areas for future cassava production;
- Improvement of availability of high yield cassava variety;
- Availability of modern technologies, innovation and Information Communication Technology;
- Improvement of land management;
- Resilience to climate change and a healthy environment;
- Reinforcement of existing laws/decrees/regulations;
- And establishment of new ones for support of farmers and other stakeholders.



Who is this story map for?

At national level, the story maps can form as a means of communication for technical spatial teams to formulate priority areas for investments in an understandable and efficient manner. Experts from Ministry of Agriculture and Forestry (MAF) can use the results of the analyses to base policy or investment related decisions on. The story maps can also be used to communicate results in between departments, teams of the MAF and relevant stakeholders of the assessed crop value chains.

CLIMATE CHANGE AND FUTURE CROP SUITABILITY OUTLOOK

Cassava is considered as a relatively climate resilient crop across different climate scenarios. However, due to extreme shifts in climate conditions, the suitable locations for cassava production are projected to change in the future. The SAMIS crop suitability maps show that the suitability of cassava currently has a mostly high or very high suitability in the northern provinces, while middle and southern provinces are high to moderate suitability at present time (figure 1a,b and 2a,b). In 2050, the suitability of cassava across 3 RCPs (2.6, 4.5 and 8.5) is projected to increase from moderate to high and high to very high in some provinces in the middle and southern provinces, while the suitability in the northern provinces is projected to stay the same, but there is a small increasing trend in northern provinces. The provinces of Borkeo, Luangnamtha, Huaophan, Phongsaly, Oudomxay and Savannakhet would show a high crop suitability in 2050. Moderate suitability would generally occur in Vientiane Capital, Salavan, Xaisomboun, Xiengkhouang, Sekong, Champasak, Attapeu and Xayabouly. Brolikhamxay, Khammoun and Luangphabang would show a marginal suitability.

The crop suitability trends are visible in the selection of map outputs from the SAMIS project that are shown below (figure 1 and 2). For two varieties (short and long cycle), the current suitability is shown (2010-2019, 1a and 2a) for low input management, and the projected future suitability (2050, RCP8.5, figure 1b and 2b) for medium input. The differences between the two time periods are shown in figure 1c and 2c, combined with the visualization of current natural conservation areas. These maps indicate the areas that are likely to increase or decline in suitability for cassava production. With this information it is possible to allocate the areas that would be most suitable for cassava production, while avoiding using natural forest area and paddy rice area as sites for future expansion of cassava production.

The trends that have influence on the future cassava production system are:

- Changing suitable areas for cassava production;
- Lack of knowledge of soil nutrient management and insufficient availability of innovative techniques;
- Unsuitable varieties for some regions;
- High occurrence of pathogens and pests;
- Lack of well-balanced policies, laws, decrees and regulations for support of farmers sectors;
- Deforestation and forest degradation due to slash and burn practices;
- And gender inequality in production and child labor.

WHAT ARE RCPs?

RCPs are Representative Concentration Pathways that describe different climatic futures under different projections of greenhouse gas (GHG) emission in the coming decades. There are four RCPs, constructed under four possible ranges of radiative forcing values in 2100. They indicate different trends in emission declines and consecutive global temperature increases (Van Vuuren et al., 2011):

RCP	Temperature increase	GHG trend
RCP2.6	~2.0°C	Strongly declined emissions
RCP4.5	~2.4°C	Slowly declined emissions
RCP6.0	~2.8°C	Stabilising emissions
RCP8.5	~4.3°C	Rising emissions

For this analysis, RCP8.5 is chosen in visualizing the crop suitability changes as outputs of the SAMIS project. As this scenario represents a scenario without climate policy and with unstopped GHG emissions, the extent of climatic possibilities is covered.

WHAT ARE INPUT LEVELS?

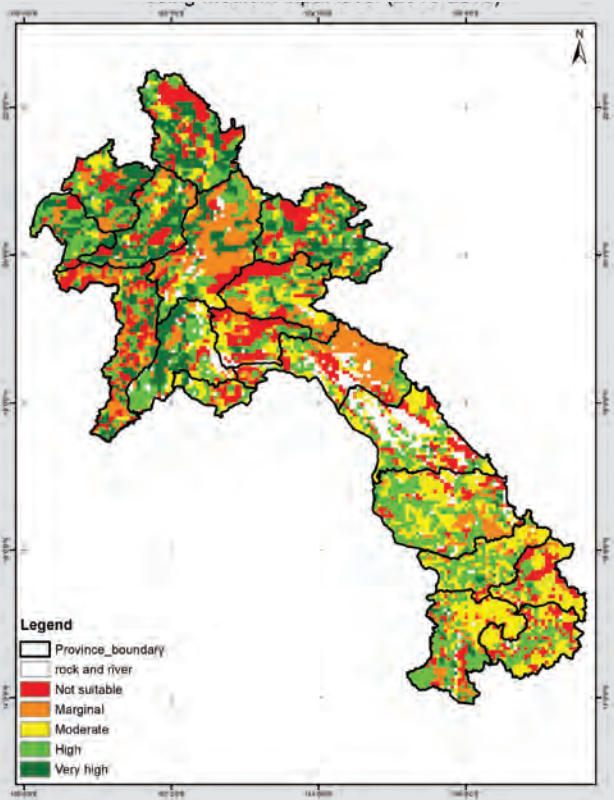
Input levels as determined by FAO are based on the level of agricultural management that is general for an area. (FAO/IIASA, 2012):

Input level	Agricultural management
LOW	traditional management, subsistence based, labor intensive techniques
INTERMEDIATE	Improved management, partly market oriented, improved varieties, some mechanization
HIGH	advanced management, mainly market oriented, commercial production, optimum use of chemical inputs

CURRENT & FUTURE TRENDS

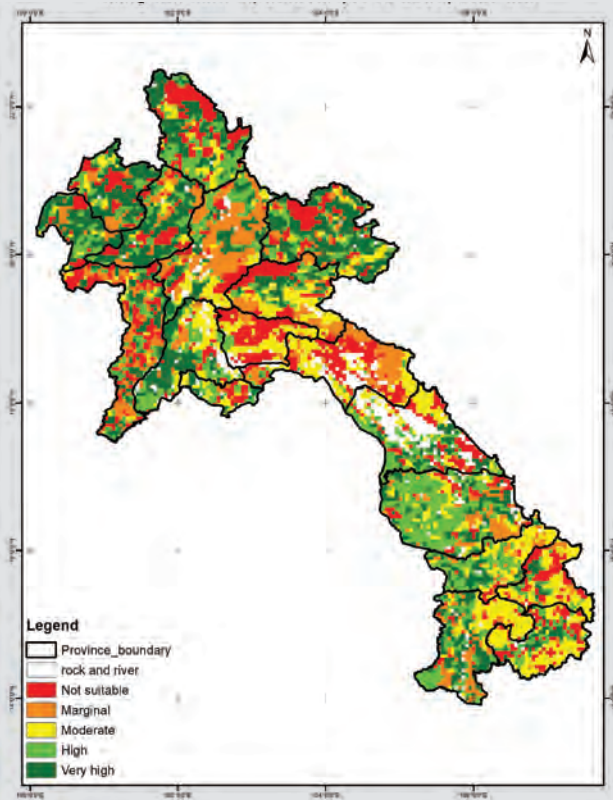
PRESENT

Suitability of cassava short cycle variety using medium input level / 2010 - 2019



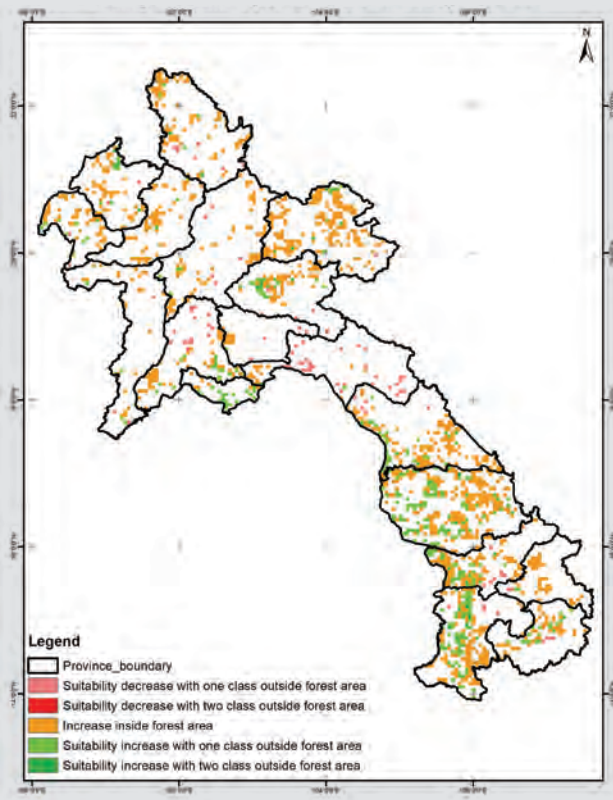
FUTURE

Suitability of cassava short cycle variety using medium input level / 2041- 2050 /RCP8.5



DIFFERENCE PRESENT AND FUTURE SUITABILITY

Suitability of cassava short cycle variety using medium input level / 2041- 2050 / RCP8.5



Source: casava suitability and hotspot map by Department of Agriculture Land Management of Ministry of Agriculture and Forestry, 2022.

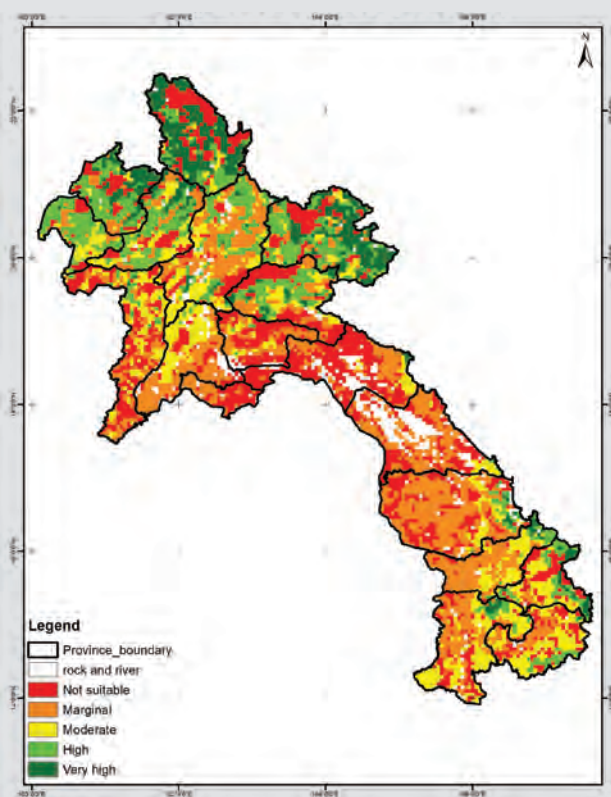
Administrative boundaries of Lao People Democratic Republic, National Geographic Department, 2013.

Figure 1: Present suitability for short cycle cassava production (2010-2019, 1a) and future projected suitability using medium input level and RCP8.5 for the time period 2041-2050. 1c shows the change in suitability class between present and future suitability, with increased suitability in forest area indicated in orange. Data are available at <https://lirms-dalam.net/?thematic=aez>.

CURRENT & FUTURE TRENDS

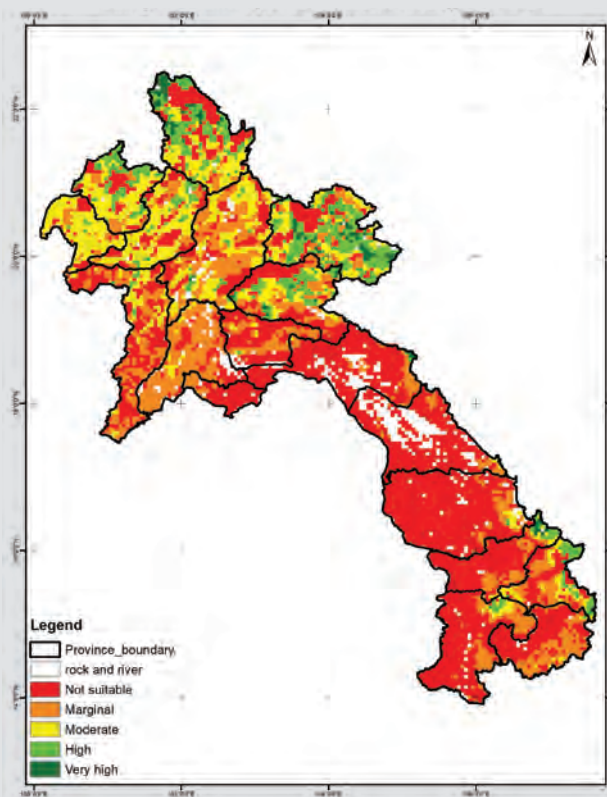
PRESENT

Suitability of cassava long cycle variety using medium input level / 2010 - 2019



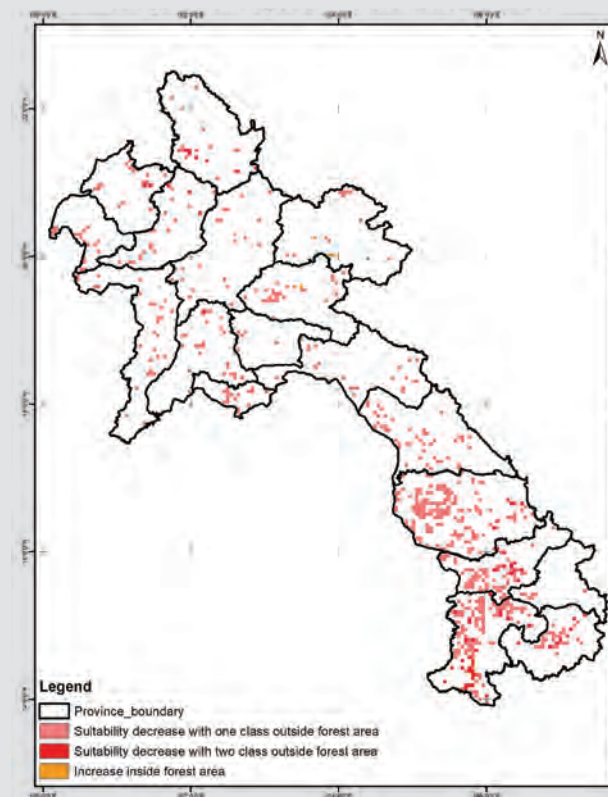
FUTURE

Suitability of cassava long cycle variety using medium input level / 2041- 2050 / RCP8.5



DIFFERENCE PRESENT AND FUTURE SUITABILITY

Suitability of cassava long cycle variety using medium input level / 2041- 2050 / RCP8.5

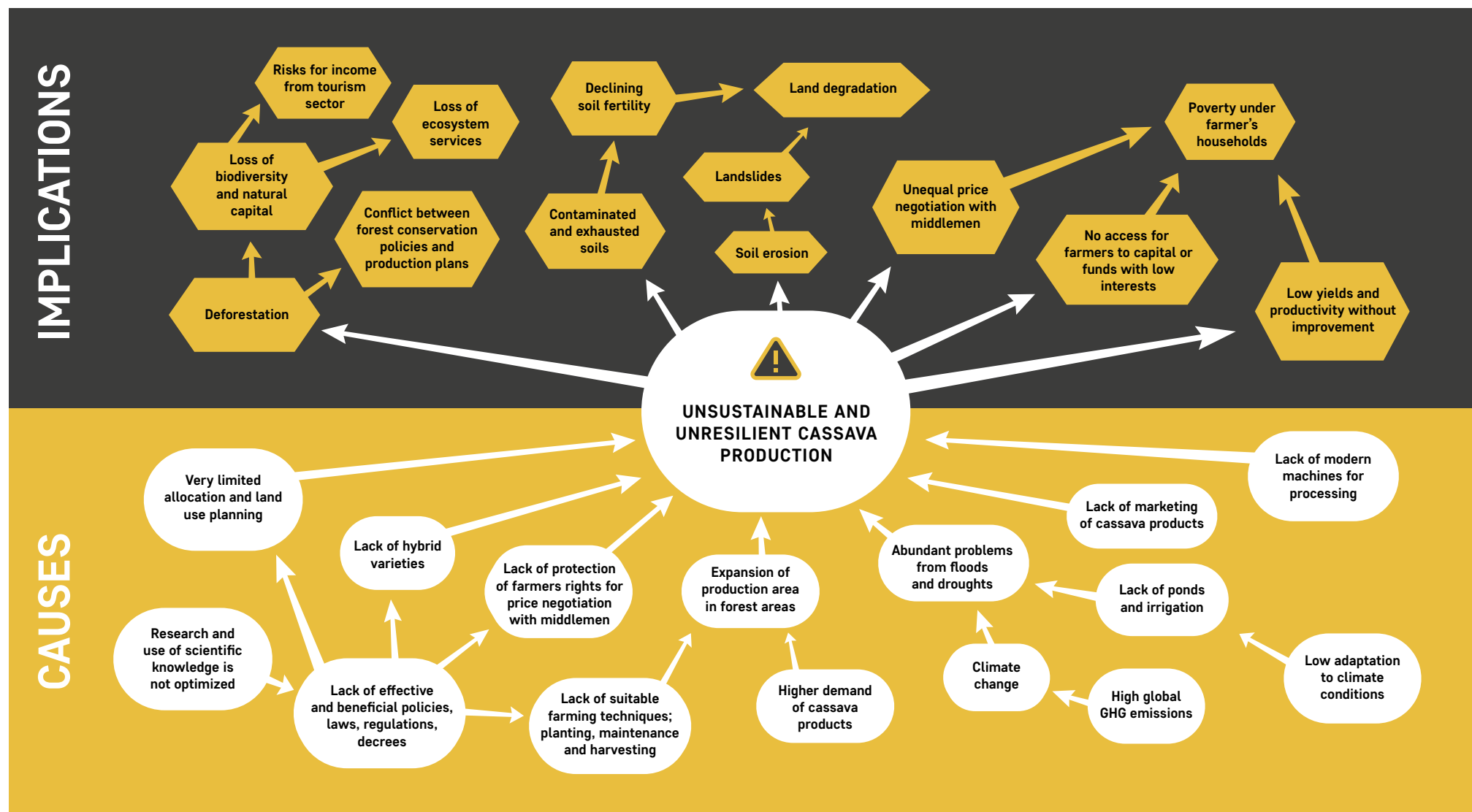


Casava suitability and hotspot map by Department of Agriculture Land Management of Ministry of Agriculture and Forestry, 2022.

Administrative boundaries of Lao People Democratic Republic, National Geographic Department, 2013.

Figure 2: Present suitability for long cycle cassava production (2010-2019, 2a) and future projected suitability using medium input level and RCP8.5 for the time period 2041-2050 (2b). 2c shows the change in suitability class between present and future suitability, with increased suitability in forest area indicated in orange. Data are available at <https://lrims-dalam.net/?thematic=aez>.

BARRIERS & UNDERLYING CAUSES



TRENDS, IMPACTS & SOLUTIONS & PRIORITY ACTIONS

	TRENDS	IMPACT	KNOWLEDGE GAPS	ACTIONS
SOCIO-CULTURAL	<p>Increase in the use of women's labor Use of child labor</p>	<ul style="list-style-type: none"> Deforestation and forest degradation; Imbalance of gender role. 	<ul style="list-style-type: none"> Information on societal issues and discrimination; Educational activities with local communities related to gender issues in northern areas; Best practices in distributing information. 	<ul style="list-style-type: none"> Women organization need to play an active role in education; Ministry of Labor and Social Welfare has to actively distribute the content of relevant regulations policies.
TECHNOLOGICAL	<p>Lack of knowledge of soil nutrient management Insufficient availability of innovative techniques Unsuitable varieties for some regions</p>	<ul style="list-style-type: none"> Crop diseases, insect plagues, overuse of fertilizer, lack of agro-processing; Low yields. 	<ul style="list-style-type: none"> Best practices for the application of available technologies in the field; Best practices in training the officers to explain technologies in the field and in how to use technologies; Knowledge on developing high technology for factories and machinery; Information on disease outbreaks and tracking outbreaks. 	<ul style="list-style-type: none"> Train how to deal with diseases, insect plagues and improving agro-processing; Construct a factory in suitable cassava area.
ECONOMIC	<p>Unsuitable varieties for some regions High occurrence of pathogens and pests</p>	<ul style="list-style-type: none"> Farmers have low incomes and support of the GDP of agriculture sector 	<ul style="list-style-type: none"> Market access, processing, easy access to funding for small and medium-sized enterprises; Information availability for smallholders on regulations. 	<ul style="list-style-type: none"> More information and training on the use of technologies and pest prevention; Enable easy access to funds; Reduce loan or rate of banks or government sector for smallholders. Banks and the government sector should put in place a beneficial credit system.
ECOLOGICAL	<p>Lack of knowledge of soil nutrient management High occurrence of pathogens and pests Deforestation and forest degradation due to slash and burn practices</p>	<ul style="list-style-type: none"> Soil degradation, soil erosion and degraded water resources; Loss of biodiversity and natural beauty; Risks for income from tourism sector Conflict between forest; conservation policies and production plans. 	<ul style="list-style-type: none"> Suitable model for soil improvement: measures can be different for different areas, proper techniques can differ per region; Sustainable land management system containing best practices on techniques; Proper use of law and enforcement to avoid deforestation. 	<ul style="list-style-type: none"> Availability of modern technology and capacity building for farmers; Suitable training by soil scientists for officers and farmers in soil management; Avoidance of slash & burn practices.
POLITICAL	<p>And lack of well-balanced policies, laws, decrees and regulations for support of farmers sectors</p>	<ul style="list-style-type: none"> No policy and regulations; And no funding and difficulty in accessing banks. 	<ul style="list-style-type: none"> And people's understanding and implementation of the law for specifically cassava production. 	<ul style="list-style-type: none"> Policy to facilitate suitable working conditions for investors and farmers; Enable easy access to funds (micro/macro economic and banks); And enforcement of use of law.



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TRENDS IMPACTS & PRIORITY ACTIONS

The trends in cassava production affect multiple elements in the production chain and have a large range of different impacts for people, the economy and the environment. In the table below, the trends have been categorized in the major STEEP categories (socio-cultural, technological, economic, ecological and political) and their possible impacts are identified. For each category, the possible actions to counteract these trends are given. To further strengthen the knowledge and effectivity of the proposed actions, the knowledge gaps that need further research are highlighted.

Key points:

- Key impacts are deforestation, imbalance of gender roles, low yield and incomes for farmers, degradation of natural resources and conflicting and lacking policies;
- Key actions are active distribution of policy content, training for farmers on disease prevention, new technologies and soil management, actions against slash&burn practices and enabling of access to funds.



BARRIERS & UNDERLYING CAUSES

Trends and drivers of change often have underlying issues or developments that cause a system to change in a certain direction. Trends are then a result and therefore a symptom of these underlying causes, as they can follow from a cascade of developments. To understand the identified trends and the barriers they form for realizing sustainable and resilient cassava production, the trends are looked at in a systems-approach. With this approach, the root causes and implications are being identified from the key barrier. This is visualized in a causal analysis framework as seen in this figure. As the deeper roots of the barriers are being investigated, the framework allows for a focus on the problems underlying the driving forces instead of symptoms.

The root causes of the trends:

- Research and use of scientific knowledge is not optimized;
- Higher demand of cassava products;
- High global GHG emissions;
- And low adaptation to climate conditions.

The root implications of the trends:

- Poverty under farmer's households;
- Loss of ecosystem services;
- Land degradation;
- And risks for income of tourism sector.

STAKEHOLDERS

The stakeholder mapping as shown in the figure below serves as a tool to understand the variety of stakeholders in the cassava value chain, as well as their influences and interactions. The results show that climate change and unsustainable farming practices not only influence farmers, but all actors in the value chain. Also, the key actors in cassava production can be identified with this figure. These key actors are the stakeholders that are most important to involve in a transformation of the system towards climate resilient production. The stakeholder groups and their components are grouped per sector and their specific interactions are indicated using arrows.

The policy frameworks and stakeholders on global, regional and national level are indicated in the box below.

GLOBAL LEVEL

The SDG Framework, UNFCCC Paris Agreement, Lao Intended Nationally Determined Contribution, Lao PDR's National Determined Contribution (NDC)

REGIONAL LEVEL

ASEAN Regional Guidelines for promoting climate smart agriculture practices , ASEAN Ministers of Agriculture and Forestry

NATIONAL LEVEL

7th National Socio-economic development Plan (NSEDP) Lao Agriculture Development Strategy, 2020, 9th national socio-economic development plan of the government for the years 2021-2025 and Agriculture Development Strategy to 2025 and vision to the year 2030

Key stakeholders and their roles:

- Reduce the risk of people health, animal health and environment pollution;
- Maintain the agro-biodiversity;
- Clean, green and sustainable agriculture;
- Reduce unnecessary production cost;
- Promote GAP;
- Manage the trade, distribution, use of biological as per recommendation for safety reasons;
- And improved land quality.

Involved departments:

MAF

NAFRI: provide the high yield variety

DOA and DTEAP: modern technology (production and processing)

DALaM: allocate suitable areas and land management

DOPLA and DOPF: regulations

Ministry of Industry and Commerce: marketing

MPI: plan and contracts MONRE (DMH): climate data Private sectors:

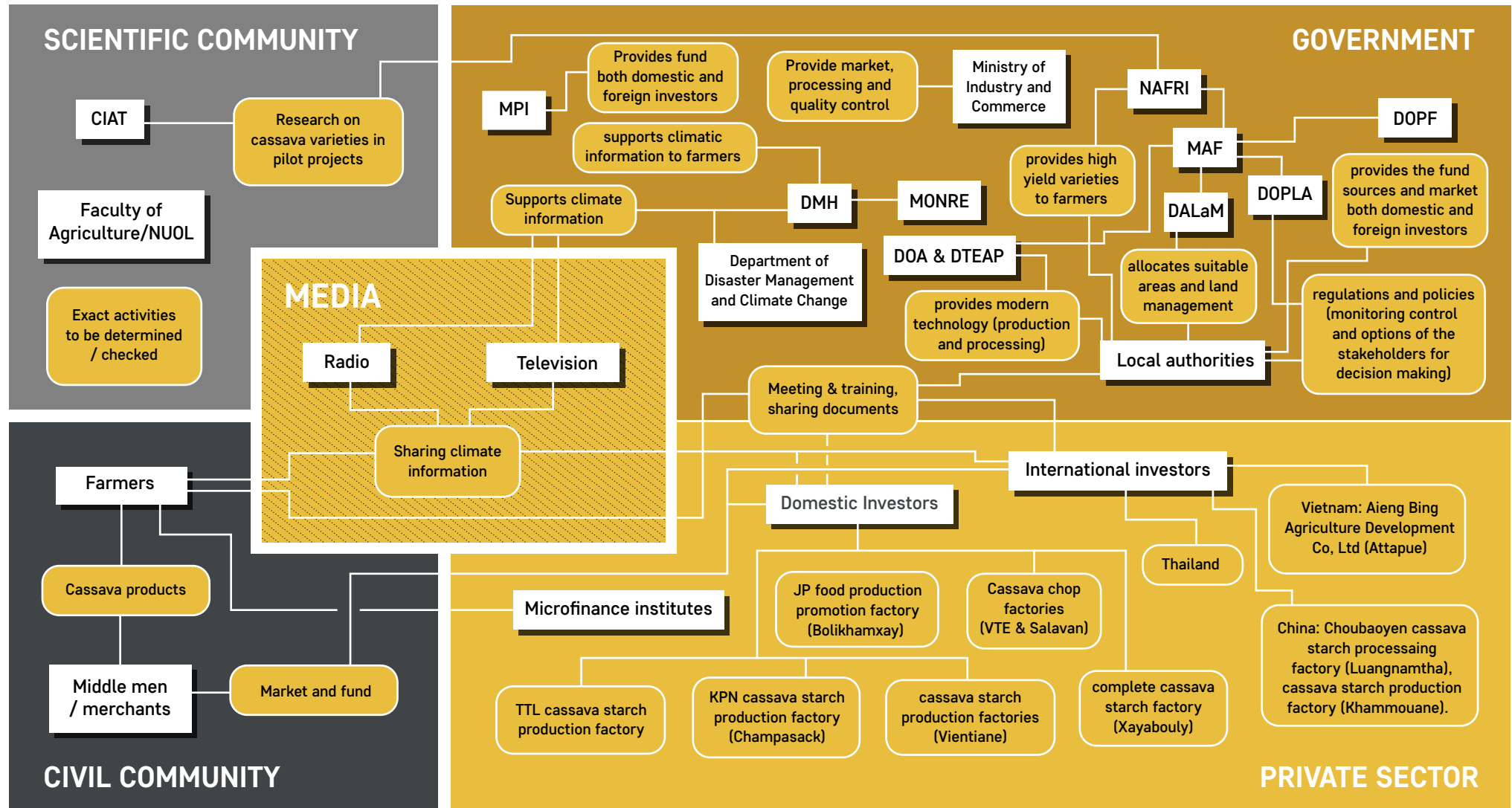
Domestic investors

International investors: China, Vietnam and Thailand

Farmers: implementors Cultivate what they need Technical or use of modern tools Maintain a clean environment.



STAKEHOLDERS MAPPING



Elaborated by the authors.

FUTURE CONTEXTUAL SCENARIOS **IMPACTS**

The contextual scenario narratives described in box 1 and 2 have been developed during the SAMIS contextual scenarios workshop of 2020 (Peou et al., 2020). The scenarios are concrete examples of what future states could look like. They are based on current developments in the agricultural sector in Lao PDR. These so-called drivers of change are then extrapolated to the year 2050. When combining a selection of these drivers, a possible future context can be sketched. A narrative of this context describes a possible future state of the sector, with two of the drivers that are dominant. The dominant drivers have a large variety of impacts on other trends, for example food security, income, migration, export values and environment, as described in box 1 and 2. The contextual scenarios give an understanding of the complexity of the food system, and explore a range of possibilities for the future. Policy documents and proposed actions can be evaluated on their robustness by imagining their effectiveness if one of these scenarios would be reality. In the table below, the trends that can be observed in the two scenarios are described. The risks and opportunities that the scenarios and trends bring about as a consequence are specified. With this information, specific recommendations are set up to respond to the developments in the scenarios. This allows for current policies to be complemented and evaluated on their robustness, to see if the proposed actions would still be adequate and in place, in case the future scenario would be realized.

Key recommendations based on the scenarios:

- Application of crop rotation and land management on cassava production farming system, for sustainable land management. This action is recommended for both scenarios;

- For scenario **AGRICULTURE IN NEED OF A RESCUE TEAM:**

Development of side activities as opportunities to increase income generation for farmers' households Credit provision should be constantly monitored to avoid misuse of credit;

- For scenario **HAPPY FARMERS:**

Motivate farmers to come together and trust the group's leadership
Distribution of information to farmers, particularly in remote areas, via loudspeaker, trader groups, production groups and village management authority by the office of Industry and Commerce.

AGRICULTURE IN NEED OF RESCUE TEAM

Less secure land ownership & high availability and skills of labor forces

In 2030, cassava production is highly specialized in Lao. The produced food is recognized nationally for its high quality and won different national prizes. However, the quantities produced by the farmers are insufficient to respond to the demand coming from different regions of Lao PDR. This is due to the insecure land ownership of farmers as over the years multiple land issues raised.

Meanwhile, the production levels of basic commodities such as rice to maintain food security cannot be kept stable and the youngsters of the village are seeking new opportunities in the main cities as incomes decrease. Key Agricultural production areas, green baskets are being left empty due to land degradation related to the use of fertilizers and pesticides. To mitigate the flux of migration the government is encouraging agro-industries to build factories in non-permanent lands. Those large lands areas are being taken by agro-industries doing intensive agriculture that decreased even more the soil fertility and have a tragic impact on the environment. Despite those big factories, people are still migrating, as the modern agriculture is mainly mechanized and only two type of jobs are available: those that required almost no skill and paid badly, and those that required degrees in science and research with high salaries. As families are regularly out of food and are facing income insecurity. There is a need to further improve public administration, especially laws, decrees.

HAPPY FARMERS

Clear land zoning & insufficient communication between government actors

In 2030, weak governmental management, relationship capacity and low technical and developmental support has led to delays in accessing local information and delivering climate hazard information to farmers and people on the ground. The level of knowledge about modern techniques of farmers is an obstacle for maintaining stable production levels of maize. It has become harder for farmers to access funding resources. There is a risk of land overuse and departments may be making different plans for the same area. Prices and import and export volumes are inconsistent between sectors due to uncoordinated data collection. Nevertheless, the land zoning plans of the government are very clear. Natural areas and sustainable use of natural resources can be maintained effectively, resulting a shift towards a sustainable agricultural sector.

AGRICULTURE IN NEED OF A RESCUE TEAM

Less secure land ownership & high availability
and skills of labor forces

TRENDS	RISKS	OPPORTUNITIES	RECOMMENDATIONS
<ul style="list-style-type: none"> • Use of high yield varieties; • Effective farming techniques; • Allocation and good management; • Advice and training is being provided; • Conflicts occur, mainly due to loss of land ownership; • Unclear land use planning; • Slow GDP growth; • Effective soil development and management; • Inadequate water supply; • And enhanced knowledge for women and children. 	<ul style="list-style-type: none"> • Soil fertility is decreasing over time due to mono-cropping systems; • And unclear credit providers for factories to operate in the right amount and interest rate to be able to run. 	<ul style="list-style-type: none"> • Technical supports by DAFO staff: training farmers on planting methods, monitoring and controlling of pests and diseases in the field; • Good formulation of negotiations on selling cassava production to traders; • And further development and transfer of farmer's skills of farmers to neighbouring farmers. 	<ul style="list-style-type: none"> • Application of crop rotation and land management on cassava production farming system, for sustainable land management; • Development of side activities as opportunities to increase income generation for farmers' households; • And credit provision should be constantly monitored to avoid misuse of.

HAPPY FARMERS

Clear land zoning & insufficient communication
between government actors

TRENDS	RISKS	OPPORTUNITIES	RECOMMENDATIONS
<ul style="list-style-type: none"> • Use of high yield varieties; • Effective farming techniques; • Allocation and good management; • Advice and training is being provided; • Conflicts occur, mainly due to loss of land ownership; • Unclear land use planning; • Slow GDP growth; • Effective soil development and management; • Inadequate water supply; • And enhanced knowledge for women and children. 	<ul style="list-style-type: none"> • Cassava diseases outbreaks by using raw stem of uncertified imported cassava stems and also from domestic farmers' fields; • Lack of flexible and systematic regulations for collaboration between farmers, for working within Village and negotiating with investors; • And market information never reaches the farmers on time (e.g., prices, available market place). 	<ul style="list-style-type: none"> • Provision of knowledge sharing between amount members; • And further development and transfer of farmer's skills of farmers to neighbouring farmers. 	<ul style="list-style-type: none"> • Application of crop rotation and land management on cassava production farming system, for sustainable land management; • Motivate farmers to come together and trust the group's leadership; • And distribution of information to farmers, particularly in remote areas, via loudspeaker, trader groups, production groups and village management authority by the Office of Industry and Commerce.



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ACTIONS & RECOMMENDATIONS

With this document, the need to include all relevant factors in the current and future production of cassava for Lao PDR is highlighted. It is highly recommended that all partners use and support the scientific output and following recommendations described in this document. Before implementation of the recommendations, it is necessary to get the permission of all relevant partners. The recommended priorities for realizing effective land use planning and a sustainable and climate resilient cassava production system are explained below. Next, the components that would help build income for farmers as well as building the national economy are described.

Priorities for effective land use planning and a sustainable and climate resilient cassava production system:

- Pinpoint suitable areas for future cassava production;
- Reduce poverty of farmers;
- Preserve environment and forest area;
- And for future cassava production, it is crucial that future suitable production areas are not inside forests and paddy rice areas.

Based on the analyses in this document, it is recommended that the following aspects are taken into account:

- There is a need to establish a consultative committee to monitor and control in terms of production process, especially usage of chemical fertilizers must under approval only;
- Also, the committee has to make essential standards and policies to facilitate in cassava production from beginning to marketing.

There are three components in order to build income for the farmers as well as building the national economy:

Component 1: Assumption on corporate among government, private and farmers sector

- Build the capacity of farmers to understand and apply innovations and technical developments for both increasing cassava production, sustain and improve soil quality and have a small environmental footprint;
- Increase the level of education by giving advice on how to use organic fertilizers in the right amounts for the supplementing the soil with nutrients;
- Build knowledge in monitoring, preventing and managing pests, insects and pathogens;
- And create knowledge channels to monitor information on the situation of demand and pricing in overseas markets.

Component 2: Decrees and regulation policies

- Develop regulations for value chains that are too complex and make them more convenient. This should be done by establishing a specific regulation and committee in order to help and support farmers and entrepreneurs in all steps of the value chain;
- The government should set up policies and the law's protections between seller and buyer;
- The government should respond to the demand and price of cassava in different countries;
- And more research on the procedure and the ways to manage the cassava production chain as well as best practices to help the people on the ground.

Component 3: Farmer's support

- Most of the farmers who plant the cassavas are poor families, lack money and their income is not sufficient for daily expenses. It is recommended to help and support them by providing new technologies like scientifically developed fertilizers and educating them in how to use it correctly to increase cassava production. The technologies should be made available by obtaining a loan or reducing interest rates between banks. Resolving these issues can help smallholder farmers in accessing the appropriate credit and remain in cassava production;
- The cassava production of the farmers in the rural area is the product of government and the economic development that can offer to the entrepreneurs;
- Appealing to the sub-government to build the conditions of convenience for the farmers that they can loan money and marketing of selling-buying science fertilizer;
- And during the expert meeting organised in March 2022, experts adding a recommendation on intercropping and transition plan.

SDGs TARGETS

The 17 Sustainable Development Goals (SDGs) were agreed on in 2015 by the Member States of the United Nations to create a better world by 2030. These goals envision the urgency to take on actions against poverty, hunger, inequality, climate change and biodiversity decline. Governments, the private sector and civilians are taking up the SDGs to indicate the societal value of their projects. This story map explains the vision of multiple relevant department of the Ministry of Agriculture and Forestry (MAF) for the future of maize production, therefore having a large influence on achieving relevant SDGs. The SDGs that are being adhered to by the analyses and recommendations indicated in this document are displayed below.



MORE INFORMATION

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