

**RSB**<sup>®</sup>

Roundtable on  
Sustainable Biomaterials

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# Pre-feasibility study on *Brassica carinata* for SAF in Ethiopia

Workshop on ICAO-EU Assistance Project Phase II  
25 July 2023

# Outline

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- Section 2 Background: Energy and decarbonisation
- Section 3 Brassica carinata production (Ethiopia)
- Section 4 Pre-feasibility evaluation
- Section 5 Takeaways and recommendations



Section 1

# About RSB



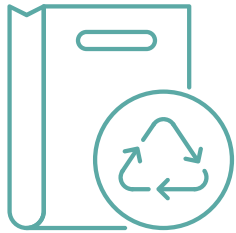
## The world we are trying to create

RSB is a global collaborative network that works to advance the transition to a just and sustainable biocircular economy



where climate change has been mitigated ecosystems have been restored and livelihoods have been enhanced

## What we do



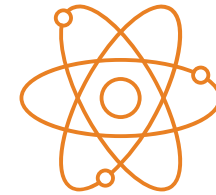
### Certification

Certification to the RSB Standard covers feedstock production, entire supply chains, and novel technologies, including fuel, biomass and material products from bio-based and recycled carbon, including fossil waste. Recognised under EU RED and ICAO CORSIA



### Implementation

Technical and strategic advice, hands-on implementation, staff training and research services at a regional and global level. We work on projects with individual partners. We also run large landscape-level projects to develop bioeconomy roadmaps with multiple partners.



### Convening

Convening stakeholder groups across private sector, industry, govts, NGOs & academia) through events, working groups, platforms to define sustainability standards and best practices, generate interest for action, and drive consensus.



Our global membership is highly diverse  
 A wide range of organisations across supply chains, regions and industries





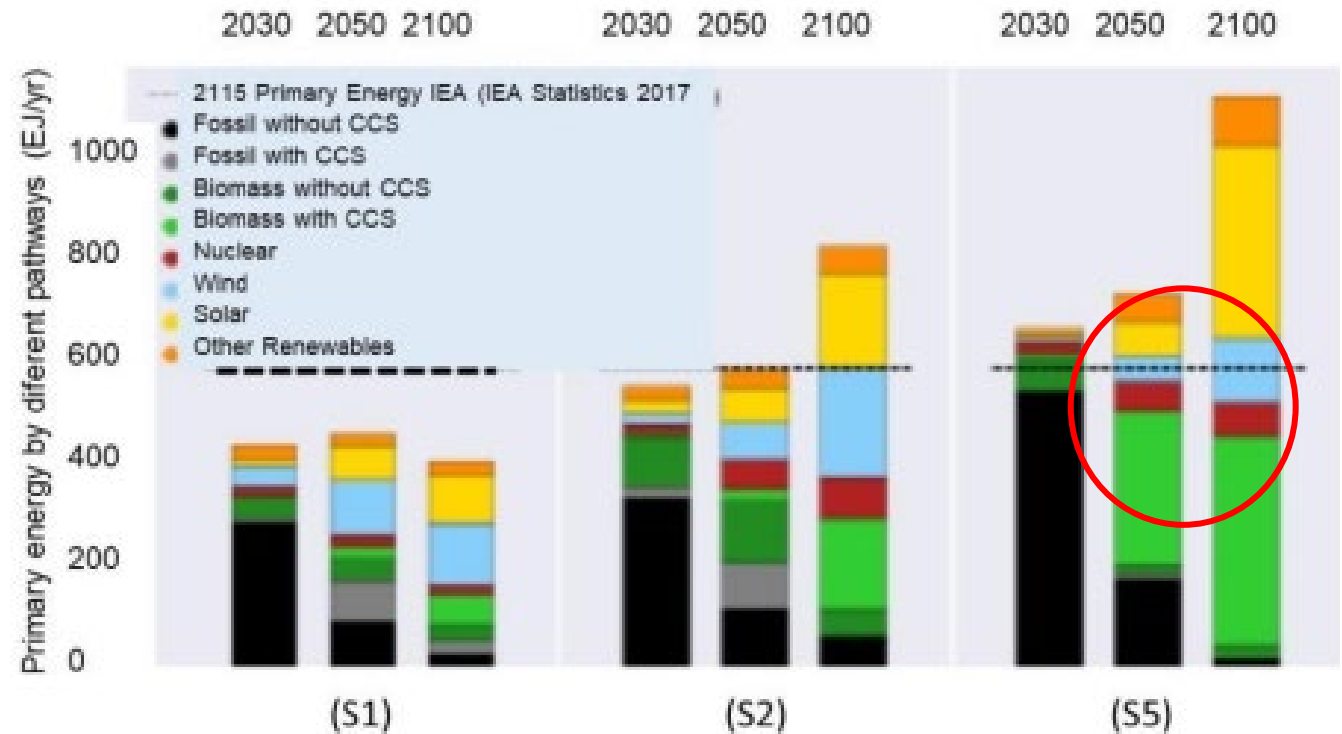
Section 2

# Background: Energy and decarbonisation



## Global projected trend

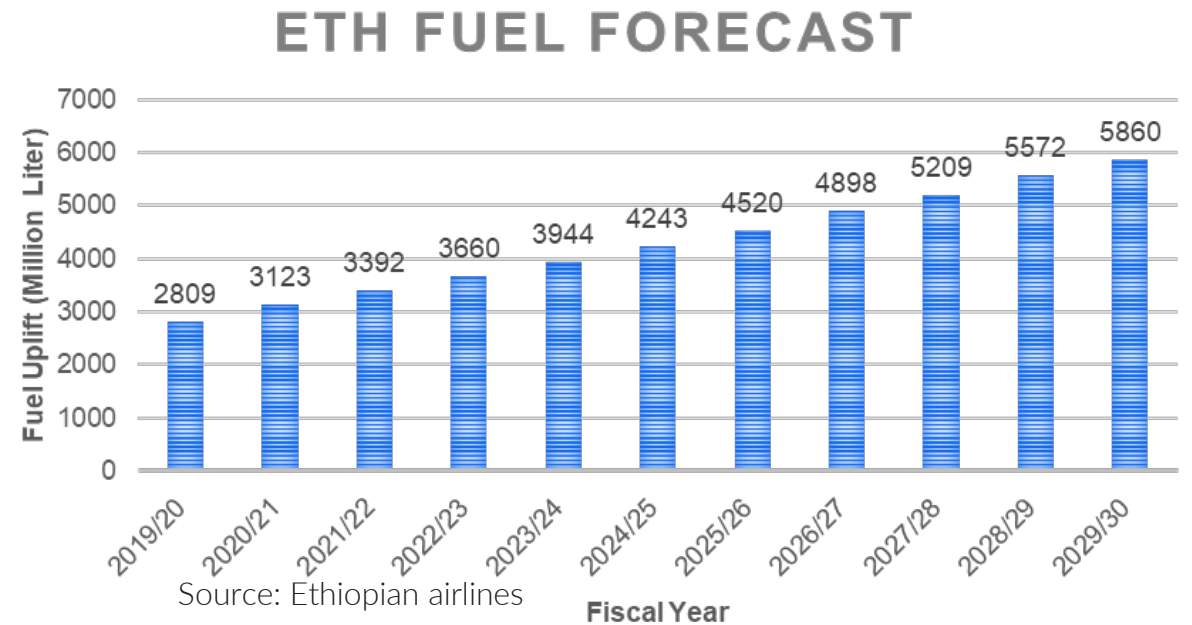
- COP21 (2015) set goal of keeping global temperature increase to “**below 2 degrees**”, and reduce it to **1.5 degrees**
- **Low-carbon biomass** feedstock production for transport biofuels is key driver to achieve low-carbon economy
- Challenges: different feedstock landscapes, economic and cultural differences, **impact the primary sector**, which is the crucial element in biofuels production
- Also, **sustainable integrated land management strategies** should be implemented; this is true for Ethiopia



Primary energy supply for the four illustrative pathway archetypes as reported in the “Perspectives for the energy transition: Investment needs for a low-carbon energy system”, IRENA, 2017

# SAF demand Ethiopia

- Ethiopian Airlines' 15-year growth strategy, aims at reaching more than 15 million tourists to Ethiopia by 2035.
- Based on this, it has predicted that its **aviation fuel demand** will reach about 5.86 billion litres by 2030
- Ethiopia launched its **Climate Resilient Transport Sector Strategy** in 2017, with the target of introducing the use of biofuels for aviation (up to 10% of mix).
- From the projected fuel demand, it can be noted that about 586 million litres of SAF are required to enable Ethiopia to reach the 10% SAF uptake.





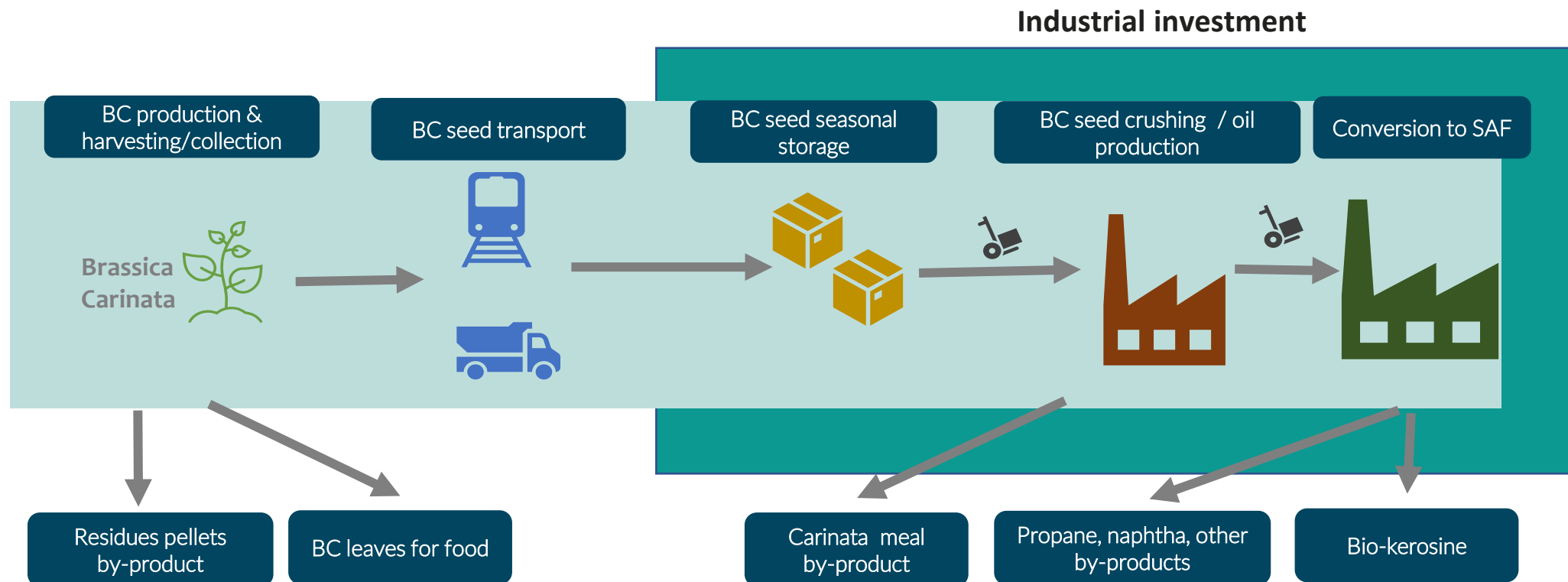
Section 3

# Brassica carinata production (Ethiopia)



# Brassica carinata value chain

- The **agricultural stage** produces the BC seed and two by-products: **residue pellets** for animal feed, and **carinata leaves** for food
- The **Industrial stage** includes the seed crushing unit for BC oil production, generating carinata meal as feed by-product and the hydrotreatment unit, for the processing of BC oil to HEFA (SAF)
- No infrastructure for BC oil crushing and of biorefineries/HEFA processing is available in Ethiopia



## Main points of the pre-feasibility study approach



International markets of **biofuels** are overarching in the development of the BC-to-Biofuel project in Ethiopia, although the internal market might impact the optimal scope and size of a specific project



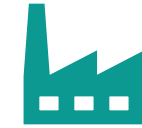
**Rotation cropping** is considered as the preferable cultivation process, especially in the beginning of the biofuels project in Ethiopia



Emphasis is put on **approximating the cost** of BC seed feedstock production under the current agricultural conditions of Ethiopia



Costs are given as a **range (min and max)** due to significant uncertainties at this stage of analysis and estimations

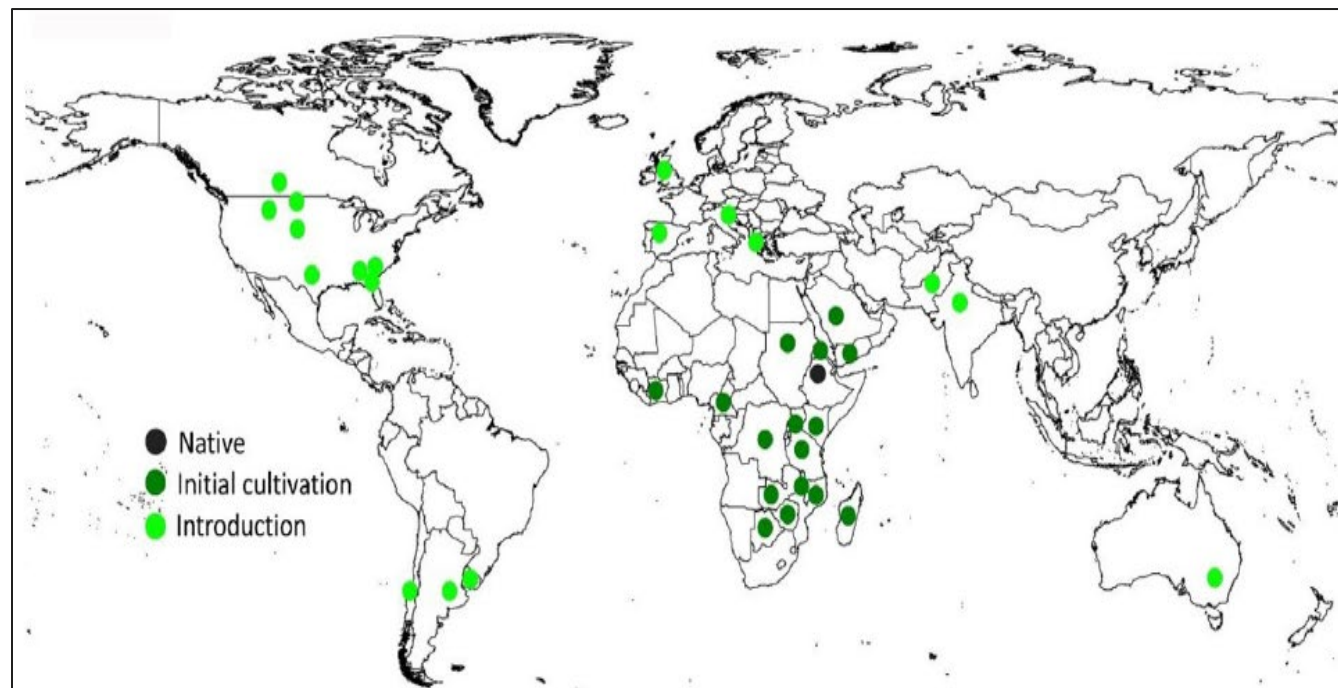


Integration of (dedicated to BC) **oil crushing and hydrotreatment industrial units in Ethiopia** is a reasonable option related to transportation costs of seeds and BC oil, and is up to investor's project development plans

# International experience of Brassica carinata

- Brassica carinata is cultivated in several areas around the world, also considering its use as a feedstock for alternative fuel.
- In Ethiopia, BC has been largely cultivated as a **leafy vegetable crop with limited commercial oil production**.
- BC is often selected as a **non-edible winter biofuel crop** because it has higher cold tolerance and greater yield potential compared to other crops such as rapeseed, camelina, etc.,
- BC, as a biofuel feedstock, is a new crop to many regions worldwide, therefore, **limited information on agronomic practices for successful production is available**.

Source: Ethiopian Petroleum Supplies Enterprise



*Brassica carinata: Biology and agronomy as a biofuel crop, Ramdeo Seepaul, et al, January 2021, GCB-Bioenergy*

## Brassica carinata production in Ethiopia

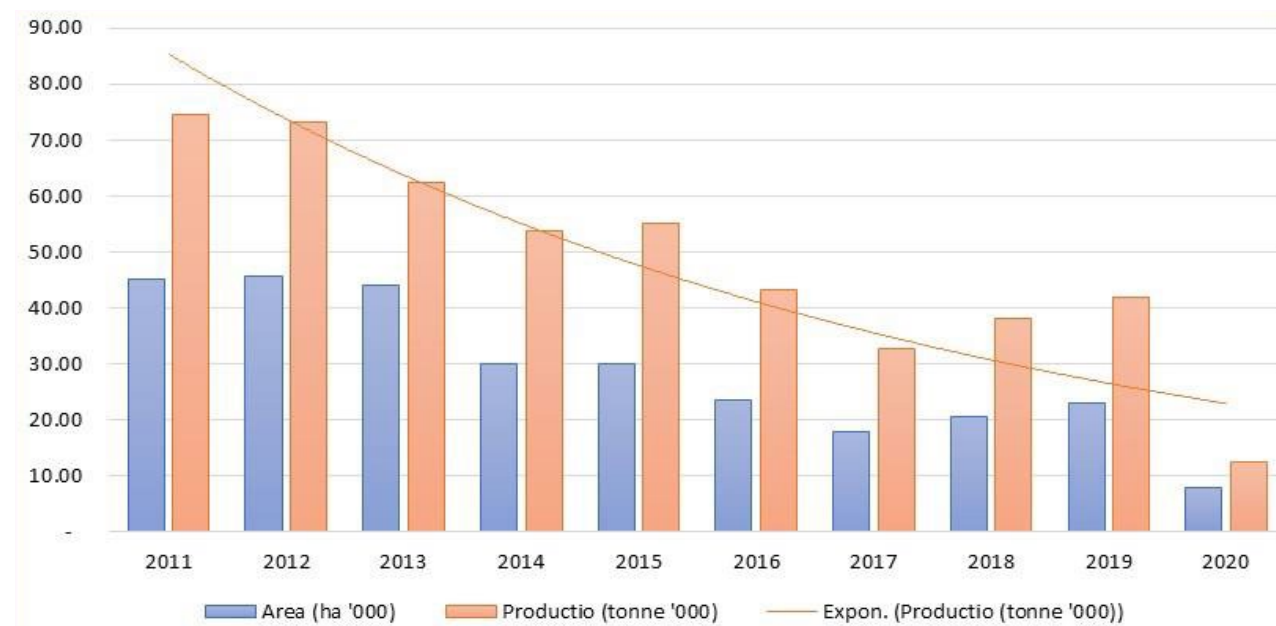
- In Ethiopia, Carinata grows in mid to high altitudes (1,700-3,200 m) above sea level. it grows best in areas within the range of 2,000-2,600 m above sea level and seasonal rainfall of 600-900 mm. Soil pH ranging from 6.0 - 7.5 is most favorable.
- Major growing areas are **Arsi, Bale, West Wallega, West Gojam** and **South Gonder**
- Production is characterized by many producers (>423,273 households of fragmented smallholdings averaging 0.02 ha in size)
- Cultivation process involves *monocropping*, *crop rotation* and *intercropped* with cereals, maize, sorghum and teff
- **BC seed** to sell it to local community for **greasing** traditional clay pans *or* to traders for export purposes



[Photos: Nuseed, [allaboutfeed.net](http://allaboutfeed.net), [allaboutfeed.net](http://allaboutfeed.net)]

# Brassica carinata production

- Total production **decreased** from 45,167,81 to 7,917,47 ha the last decade
- Total volume of production **decreased** from 74,666,356 tons to 12,575,789 tons
- **Reasons for output reduction:**
  - land competition with cereals (barley and wheat)
  - lack of inputs, irrigation, improved seed varieties, mechanisation (tillage)



EXERGIA elaboration with data from CSA and other national sources

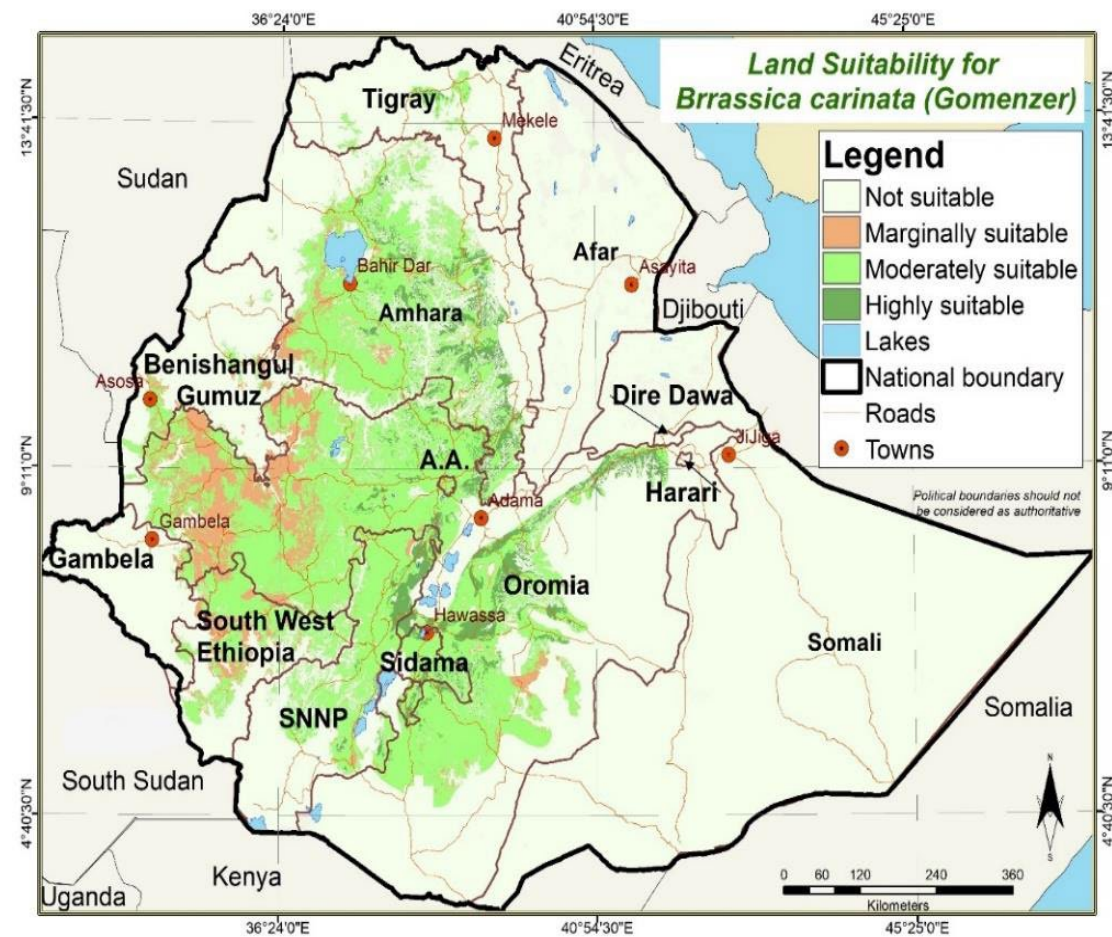
## Brassica carinata production

- Besides the smallholder farmers, there are states that own **commercial farms** in Ethiopia
- These companies used **mechanisation** and produce Brassica Carinata in crop rotation with cereals
- To improve production and productivity more than 10 varieties were released with **Yellow dodola** being the most demonstrated and adopted: This variety is characterised by **high seed productivity (2 ton/ha)** and **high oil content (44%)**, while it is stable and adapted to major growing areas of Ethiopia

Name of variety	Year of release	Productivity (Q/h)		Oil content (%)	Days to maturity
		Research field	Farmers field		
Tesfa	2018	24	-	-	147
<b>Derash</b>	2018	23	-	46.8	145
Holetta-1	2005	30.3	15	39.1	150
<b>Yellow dodola</b>	1986	30.2	20	44.1	156
S-67	1976	30	17.8	40.5	157

## Land suitable for Brassica carinata

- ModelBuilder application of ArcGIS used for constructing, editing, executing workflows and spatial analysis.
- Parameters used : length of growing period, altitude, slope, soil properties, rainfall and temperature during growing period.
- Unappropriated land for cultivation was excluded: Lakes, parks/protected areas, lands with greater than 30% slope
- Abundant suitable land for production (29,902,340 ha)
- 3,124,044 ha is highly suitable,
  - 22,714,012 ha is moderately suitable; 4,064,284 ha is marginally suitable, and 79,838,004 ha is unsuitable
- Oromiya has large proportion of suitable land, followed by Amhara and SNNP



Suitability map of Brassica Carinata in Ethiopia



Section 4

# Pre-feasibility evaluation



# Assessment of cost and revenues

## Supply chain associated costs

- Estimation of the supply chain and the associated costs for cultivation of BC in Ethiopia has been based on **cost data** obtained directly from growers
- Labour, input, transport, other costs have been considered

The total cost of BC production:  
from 410 USD/hectare to  
580 USD/hectare

## Revenues from by-products

- Assumptions:
  - Brassica carinata leaves (BCL): 3,500 kg/ha;
  - Brassica carinata straw (BCS): 4,000 kg/ha;
  - Selling price of BCL: 0.31 USD/kg;
  - Selling price of BCS: 0.13 USD/kg
- Total revenue from selling the byproducts is estimated at 1,605 USD/hectare under current conditions but under the assumption of a massive production a more conservative additional revenue is considered (10%)

A conservative estimation of  
additional revenues  
160 USD/hectare

## Indicative comparison of cultivation cost and revenue

- Published data for USA, Canada, Italy and Europe were considered
- Very different underlying assumptions in each work
  - necessary assumptions were made to overcome the lack of unified information
- Income from selling BC leaves also considered in the estimation of final revenue

Region	Cultivation process	Estimated feedstock cost (USD/ha)	Farmer net revenue (USD/ha)
<b>Italy</b>	Rotation	329.20	n.a.
<b>United States</b>	Cover cropping	537.95-903.66	n.a.
<b>Canada</b>	Cover cropping	680	n.a.
<b>ETHIOPIA</b>	<b>Rotation</b>	<b>410-580</b>	<b>677-847</b>
<b>Europe (2030)</b>	Intercropping, cover cropping, rotation, biochar	220-508	360-685

Source: Data elaboration by Project Team

# Environmental and social impacts

- As there are no installed industrial units of oil extraction for Brassica Carinata and biorefineries or hydrotreatment industrial units in the country, the **assessment was made only for the Brassica carinata crop production**
- The evaluation was performed against the 12 RSB'S sustainability principles (see the report)

Principle	Requirement	Existing situation
<b>Principle 1: Legality</b>	Biofuel operations shall follow all applicable laws and regulations.	> The new Proclamation 1180/2020 and Regulation No. 474/2020 launched by Ethiopia Investment Commission states all the requirements for an investor
<b>Principle 2: Planning, Monitoring and Continuous Improvement</b>	Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent and consultative impact assessment and management process and an economic viability analysis.	> The Environmental Impact Assessment (EIA) Proclamation (No.299/2002) is adequate for meeting this principle.
<b>Principle 3: Greenhouse Gas Emissions</b>	Biomass and biomaterials shall contribute to climate change mitigation by significantly reducing life cycle GHG emissions as compared to fossil fuels.	> Detailed analysis of the life cycle GHG emissions is required for this principle. The required data for analyzing greenhouse gas emissions for Brassica carinata crop production using RSB GHG tool is presented on Annex 5 of the report
<b>Principle 4: Human and Labour Rights</b>	Biofuel operations shall not violate human rights or labour rights and shall promote decent work and the well-being of workers.	> Thus, the existing law is adequate for meeting this principle if implemented successfully.
<b>Principle 5: Rural and Social Development</b>	In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural, and indigenous people and communities.	> Agricultural and Rural Development Policies and Strategies (ARDPS, 2002) address some of the requirement. No explicit standard is stated in the document to enforce provisions; thus, additional directives are required.
<b>Principle 6: Local Food Security</b>	Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions	> Brassica Carinata can be grown in crop rotation and doesn't compete with food crops. Hence, it satisfies the requirement on this principle.
<b>Principle 6: Local Food Security</b>	Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions	> Brassica Carinata can be grown in crop rotation and doesn't compete with food crops. Hence, it satisfies the requirement on this principle.
<b>Principle 7: Conservation</b>	Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.	> Development Conservation and Utilization of Wildlife Proclamation No. 541/2007 and Forest Development, Conservation and Utilization Proclamation (No.542/2007) address the standard requirement in this principle.
<b>Principle 8: Soil</b>	Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.	> Brassica carinata is a very potent grass weed suppressor that if it grown in crop rotation decrease the use of herbicides and maintain soil health.
<b>Principle 9: Water</b>	Biofuel operations shall maintain or enhance the quality and quantity of surface water and groundwater resources, and respect prior formal or customary water right	> Ethiopian Water Resources Management Proclamation (No. 197/2000) meets the standard requirement regarding this principle
<b>Principle 10: Air</b>	Air pollution from biofuel operations shall be minimized along the supply chain	> The existing Pollution Control Proclamation No. 300/2002 is adequate for meeting the standard requirement regarding this Principle
<b>Principle 11: Use of Technology, Inputs and Management of Waste</b>	The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people	> Low input application and minimum tillage are major characteristics of Brassica carinata growing fields in Ethiopia. > There is generally lack of agricultural inputs, improved seed varieties, inadequate extension service and large-scale mechanization.
<b>Principle 12: Land Rights</b>	Biofuel operations shall respect land rights and land-use rights	> The existing Rural Land Administration and Utilization Proclamation (456/2005) is adequate for meeting the standard requirement regarding this principle



- A detailed Environmental and Social impact assessment of Brassica carinata is needed against pre-defined environmental (e.g. GHG savings) and social indicators (e.g. food security, gender issues, land tenure, job creation, etc.)
- RSB'S sustainability principles are either readily met – pieces of secondary legislation are needed
- Compliance to RSB is important (CORSIA, etc.)



Section 4

# Takeaways and recommendations



# Recommendations

1. **Attracting the necessary investment** becomes the major **priority** to launch the “BC-to-SAF” project.

2a. **Agricultural part** of the value chain:

- Competition with other crops, personal preferences of farmers, feedstock market volatility, long-term perspective of business, cultivation risks, etc., are factors hindering scale-up of sustainable biofuels production
- *Institutional development and awareness campaigns, capacity building*
- *Establishment of strong linkages among the farmers’ associations and the agro-industry institutions.*
- *The scale up of the few existing pilot projects*

2b. **Sustainability certification** is a prerequisite to provide access to the international market.

3. **Industrial part** of the value chain: technologies are ‘international’, but a detailed feasibility study should be undertaken to optimize infrastructure location (Ethiopia or abroad) and production profile (fuels, quantities)



Feasibility risk



Feedstock availability risk



Market uptake risk



Profitability risk

Initial state interventions should concentrate on **inviting investors to develop agricultural and industrial parts**; establishing a **strong project management governance** reflecting on the interest of an international companies

# Questions and discussion



For more information on the RSB visit  
**[www.rsb.org](http://www.rsb.org)**

Or email: **[yitatek.yitbarek@rsb.org](mailto:yitatek.yitbarek@rsb.org)**