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**JATRO**  
**POWER**

Bio-Oil Production along with Carbon Sequestration  
and Storage with *Jatropha curcas* plus

# Jatropower AG - footprint



Starting year: 2008, key personnel in jatropa sector since >20 years

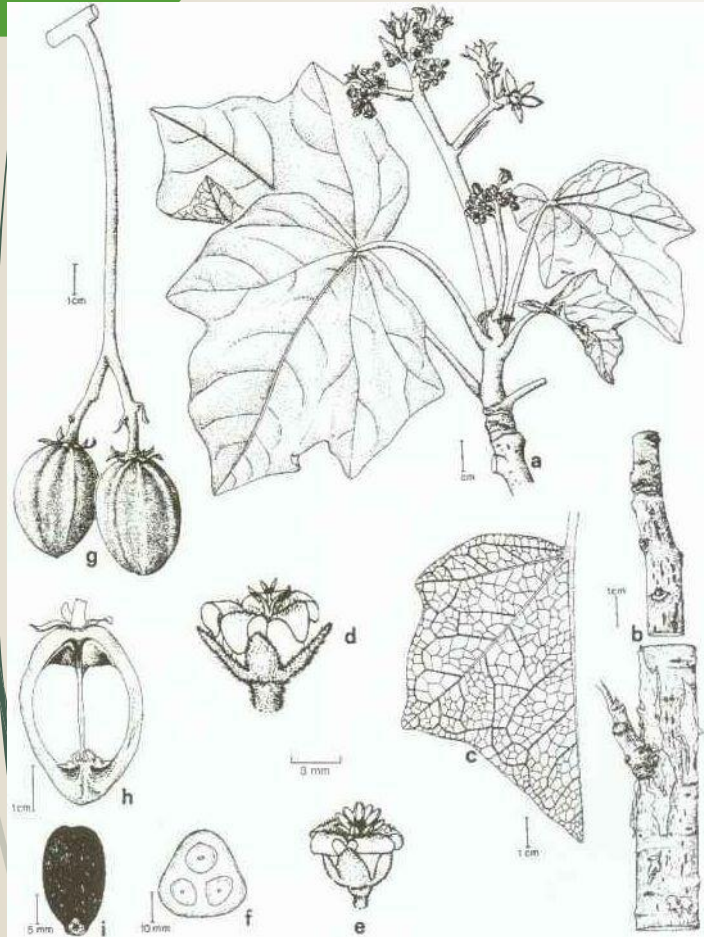
Financing: private equity of the promoters

Facilities: Own research farms and laboratory, collaborative research on client farms,

Research collaboration: Public universities and research institutes in Germany, Italy and India

# Jatropha curcas - botany

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Family: Euphorbiaceae

Perennial shrub – grows to about 5-6m height

Common name – Physic nut, purging nut

Fruit weighs about 2g (60% seeds and 40% pericarp)

Origin: Mexico and Central America (??)

Occurs in tropical America, Africa and Asia

a - a flowering branch, b – bark, c – leaf veinature, d – pistillate flower, e - staminate flower, f – cut through immature fruit, g – fruits, h – longitudinal cuts of fruits, i - seed

## Why *Jatropha curcas*?

- *Jatropha* seeds contain more than 35% oil that is a suitable feedstock for biodiesel and hydrotreated vegetable oils (HVOs)
- There is an edible variety of *jatropha*, named Xuta, which can produce multi-purpose oil and food/feed protein
- Perennial plant yielding for more than 20 years after plantation
- Adaptable plant that uses soil nutrients and water efficiently
- Can grow on eroded, nutrient poor land and improve the quality of soils over time
- Seeds easy to harvest, store and process
- High potential for carbon sequestration, especially when planted on denuded land

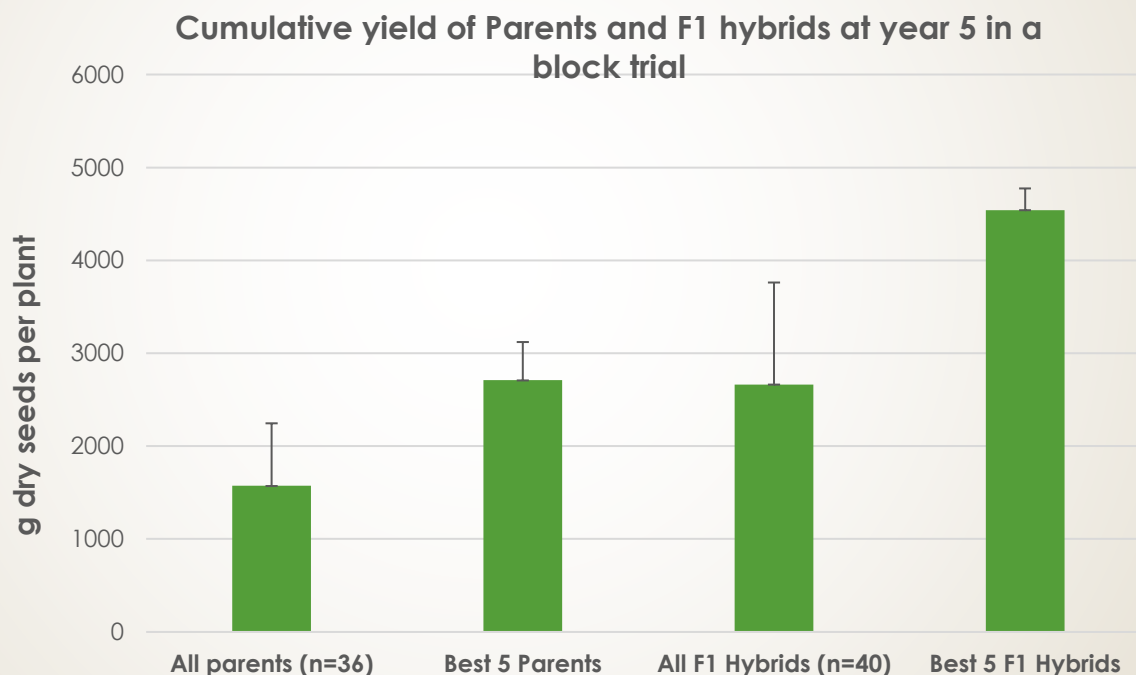


## Two main *Jatropha curcas* lines are under development

- ▶ Jatropower is developing two varieties of *Jatropha* parallelly
  - ▶ The conventional toxic variety named *Jatropha* – main product is oil as a biofuel feedstock and by-product is seed cake as fertilizer
  - ▶ A new edible variety of *Jatropha* named Xuta – the products are:
    - ▶ Seed oil for use as multipurpose oil, like rapeseed and soy oil
    - ▶ Seed kernel meal as human food and animal feed ingredient
    - ▶ Seed shells as biomass burning fuel
    - ▶ This variety occurs naturally in Mexico and Jatropower has improved it by selection and breeding
- ▶ The difference between the Xuta and *Jatropha* is the absence of the toxic factor, **phorbol esters** in the former.

# Breeding process and progress – seed yield improvements

Key tools employed: Monitoring, selection and hybridisation



**Semi-arid climate and degraded soil framework under which these yields have been obtained:** Rainfall: average below 400 mm p.a., soil texture: stony, pH: 8.2, Soil fertility: deficient in N and P and micronutrients such as B and Fe, Soil depth: 30 cm, Irrigation: 14 litres every 14 days during rain-free months

# Breeding process and progress – increasing genetic variability

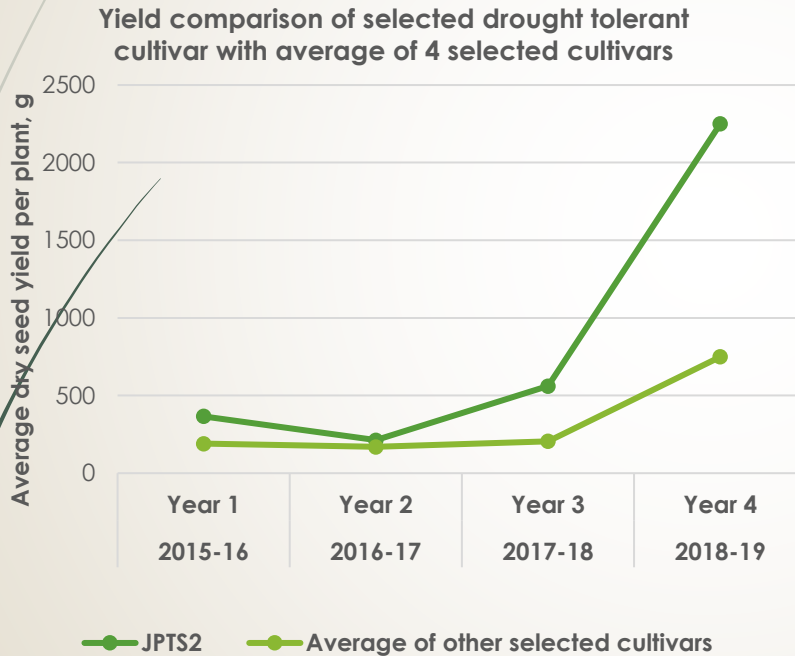
Generation of new high yielding derivatives through Apomixis



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# Other breeding goals and tools

## Drought resistance



Irregular rainfall and even more frequent droughts are increasing in the jatropha growing areas due to climate change

## Deployment of pistillates for scaling F1 hybrid seed production



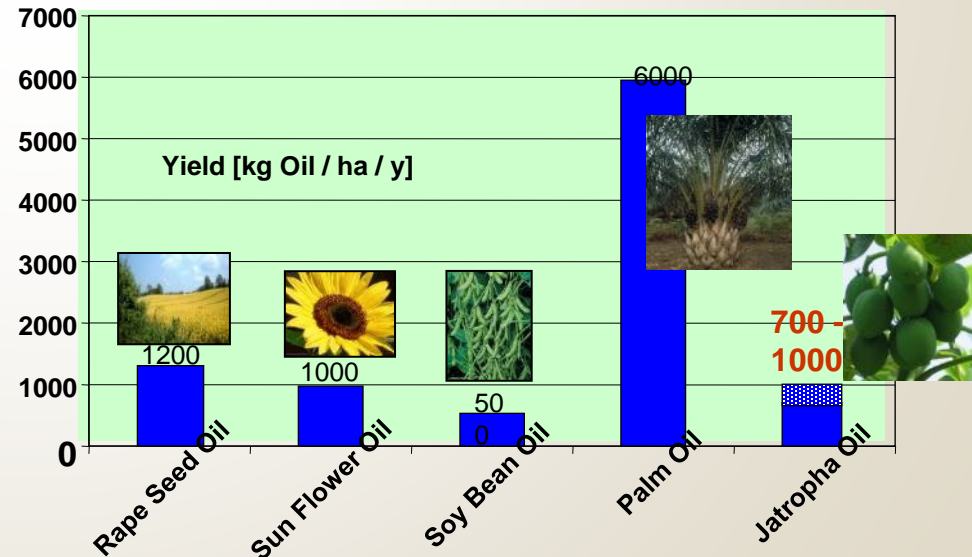
Pistillate J curcas with only female flowers, Jatropower has developed the non-edible and edible pistillate jatropha plants



# Which seed yields are realistic on sub-optimal land?

- Jatropha yield is determined by genetics and agronomy in equal share
- The land available for cultivation is usually not suitable for other crops
- On such land with limiting conditions, with good management, around 2.5 tonnes of seeds per ha per y (750kg oil) per ha per year would be possible with the current breeds
- Under better agronomic conditions, better yield will be possible with the current breeds, with some reports pointing to >4 tonnes of seeds per ha per year.

**Jatropha compares well with established oil crops**

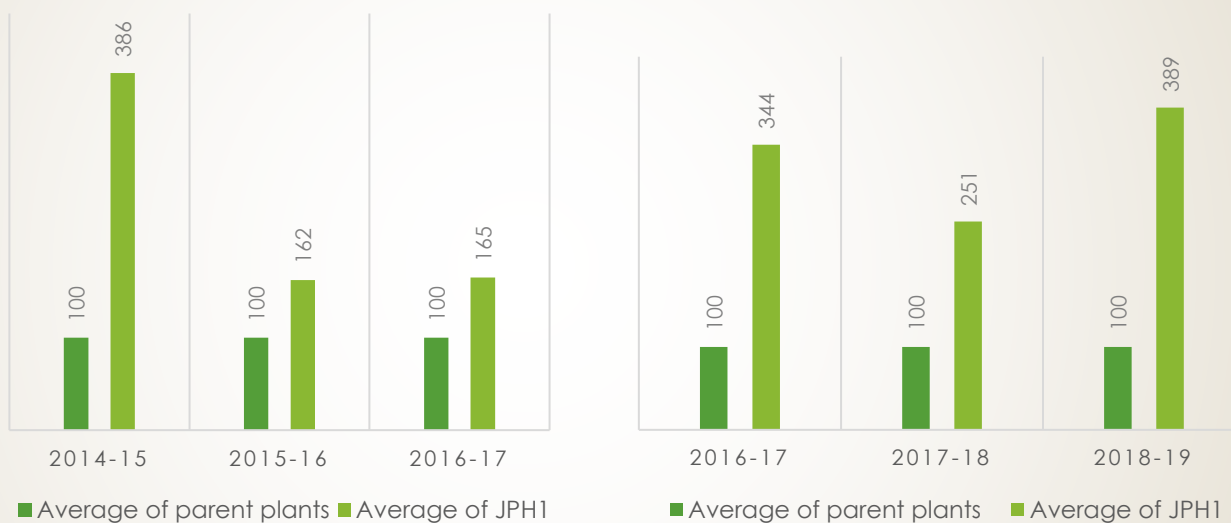


JP F1 hybrid **JPH1**, early and profuse fruiting



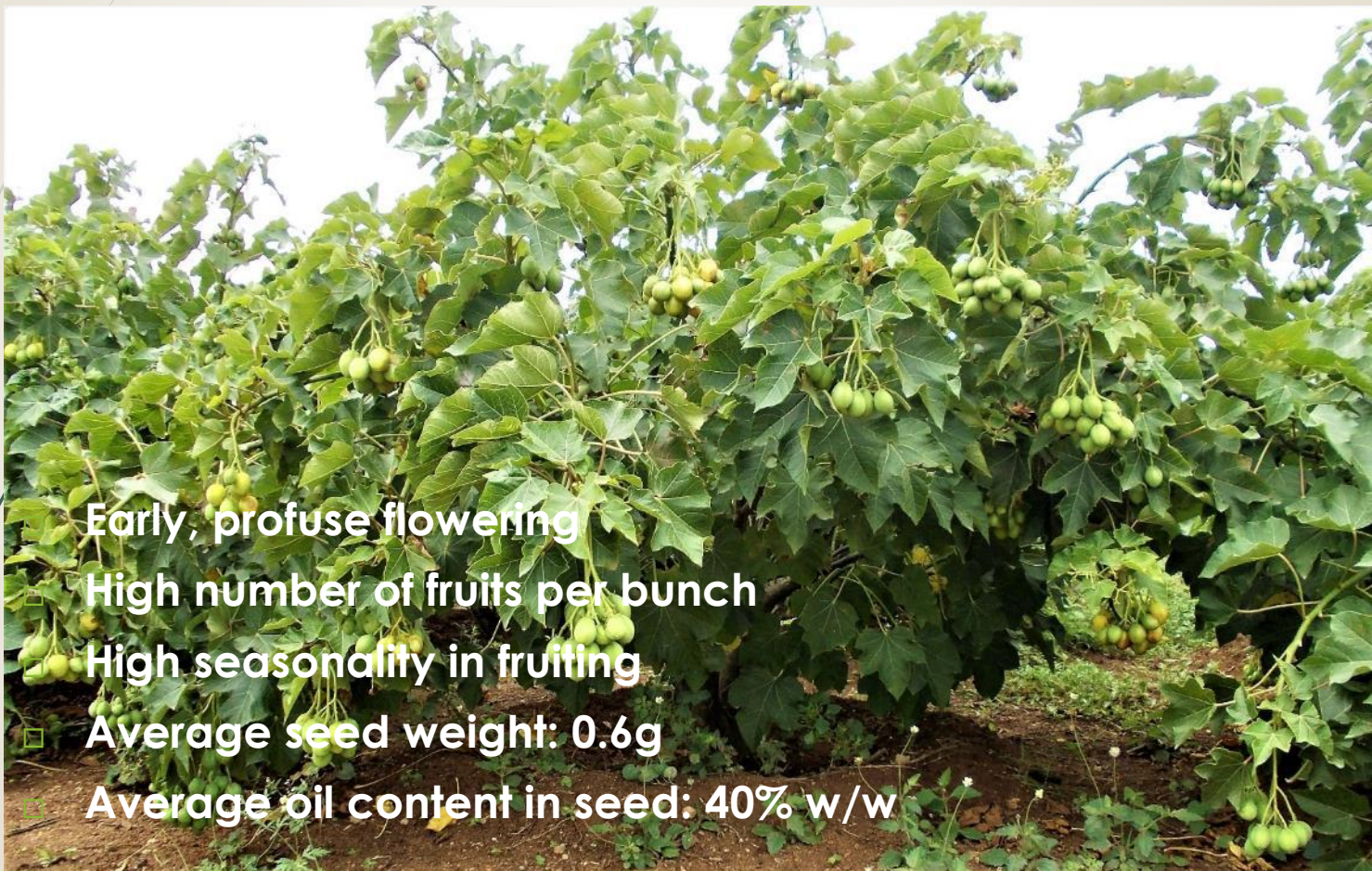
# The F1 hybrids perform better also under stressful climatic conditions

Percentage dry seed yield increase of JPH1 over its parents over 3 years under two trial conditions\*



*\* 2015-16, 16-17 and 17-18 were extreme drought years at both the sites in S. India where the trials were conducted.*

## Jatropower's JPNT-1, world's first commercial Xuta cultivar



Early, profuse flowering

High number of fruits per bunch

High seasonality in fruiting

Average seed weight: 0.6g

Average oil content in seed: 40% w/w

# Jatropha/Xuta fruit and proportion of its fractions



Dry Fruits 100 %



Seeds 60 %



Husk 40 %



Kernels 65 %



Shell 35 %



Oil 60 %



Kernel meal 40 %

# Composition of Jatropha/Xuta fractions

	Husk	Shell	Meal	Cake	Oil
<b>Dry matter (%)</b>	91	90	90-95	90.5	
<b>Water content (%)</b>	9	10	5-10	9.5	
<b>Gross energy MJ/kg (on dry matter basis)</b>	15.5	18	18	19.5	39.5
<b>Crude protein (% in DM)</b>	6	4	57.5	23	
<b>Lignin (% in DM)</b>	14.5	45	0.5	22.9	
<b>Hemicellulose plus cellulose (% in DM)</b>	51.5	40	9	23.9	
<b>Total carbohydrates (cellulose + hemicellulose + starch and soluble sugars; % in DM)</b>	51.5	40	26.5	31.2	
<b>Ash content (%DM)</b>	15 - 16	4 - 6	10		

Jatropha/Xuta oil is suitable for conversion to renewable diesel/aviation spirit

### Physical/chemical properties of Jatropha/Xuta seed oil

Calorific value	37.8 MJ/kg
Appearance	Light yellow liquid
Specific gravity at 30°/30°	0.92
Acid value	1.24
Saponification value	197
Iodine value	102
Unsaponifiable matter	0.4%

### Main fatty acids in Jatropha/Xuta seed oil

Oleic acid (18:1)	36-42%
Linoleic acid (18:2)	36-43.5%
Palmitic acid (16:0)	11.6-12.6%
Stearic acid (18:0)	6.5-8%

# Xuta kernel meal have been shown to be of high nutritional quality

Ingredients	Proximate Composition in g per kg dry matter				Most limiting essential Amino Acids in g per 100 g protein				
	Crude Protein	Lipids	Ash	Gross Energy (MJ)	Lysine	Methione	Cystine	Isoleucine	Tryptophan
Fishmeal	635	88	142	21,1	6,44	2,52	0,68	3,54	0,77
Soybean meal	471	11,7	22,6	18,2	6,18	1,32	1,38	4,16	1,36
Defatted Kernel Meal of Jatropower	624	12,1	91	18,3	3,45	1,58	1,70	3,97	1,07
Reference protein 2-5-year-old children according to FAO	-	-	-	-	5,80	2,50*	-	2,80	1,10

\* including Cystine

There are several refereed publications that have shown the high nutritional quality of Xuta oil and kernel protein in a range of test animals.



## Use of the whole seed cake of jatropha

### ➤ **Bio fertilizer cum bio pesticide**


- Contains 5.7–6.5% N, 2.6–3.0% P<sub>2</sub>O<sub>5</sub>, 0.9–1.0% K<sub>2</sub>O, 0.6–0.7% CaO and 1.3–1.4% MgO
- The phorbol esters contained acts as a pesticide against harmful soil organisms
- There is proof that the jatropha phorbol esters are completely destroyed within 6 days once applied in the soil
- Our own trials have clearly shown fertilizer and soil improvement value of jatropha whole seed cake
- Jatropha seed cake has high demand for fertilizer purposes in India in our experience

### ➤ **As a substrate for production of biogas**

# Jatropha plantations on wasteland established using Jatropower's elite seeds



Pictures taken from the EnBW jatropha project in Madagascar that uses Jatropower's elite seeds for its plantation on denuded wasteland



The standardised elite seeds (JPNT1 in this case) are capable of robust and uniform growth under stressful soil and climate conditions,

Agricultural technologies have been developed for wasteland cropping

Given the extremely poor soil conditions, betterment measures are adopted to increase soil texture and organic content

Pictures taken from the EnBW jatropha project in Madagascar that uses Jatropower's elite seeds for its plantation

Agricultural technologies have been developed for wasteland cropping

The leguminous intercrops and cover crops help the jatropha plants and to reclaim the soil eventually

Pictures taken from the EnBW jatropha project in Madagascar that uses Jatropower's elite seeds

The plants establish well and develops good standing biomass in quick time under sub-optimal conditions

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**18 month old edible jatropha cultivar cultivar JPNT1 on wasteland in Madagascar**

## A first assessment of the CO2 credit generation potential made for the Madagascar jatropha project

- ▶ The project is eligible under Gold Standard (GS) and Verra (VCS) platforms as a CO2 sequestration project to obtain Voluntary Emission Reduction (VER) credits
- ▶ Under the GS requirements, the crediting period shall cover at least 30 years
- ▶ A net CO2 sequestration of 4.8 tonnes per hectare and year was assessed based on the biomass growth on the ground, after subtracting baseline C under the project-site conditions and the 20% risk margin required by GS
- ▶ The VERs generated has good demand, given the quality of the project and the high UN-SDG impacts, especially SDGs 3, 5, 6, 7 and 13.
- ▶ Negotiations under the Paris agreement and its eventual acceptance will result in still higher demand (and prices) for the VERs

# Experience of partner, Jatrosolutions Cameroun in the Sahel zone

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Pictures from Ossere Faouro, Garoua, land on the desert edge  
before planting (left) and 2 years after planting *J. curcas* (right)  
***Pictures credit: Dr Euloge Dongmeza***



Jatropha can adapt even to extreme climatic conditions, provided water is provided (sewage water in this case)

The CO<sub>2</sub> sequestration potential is even higher under these conditions



**Jatropha curcas can grow and yield seeds even in hot deserts if irrigated.**

**The picture shows a Jatropha plantation in Luxor, Egypt irrigated with sewage water** (photo taken with permission from the Egyptian ministries of Environment and Agriculture, to whom the plantation belongs)

## Subsidiary crops in portfolio that offer diversification options in/around jatropha plantations

### **Moringa oleifera Lam.**

- Has come to be known as a “Miracle tree”
- Quick growing and drought tolerant
- Short-duration and perennial crops possible
- Separate “pod varieties” and “leaf varieties” are under development
  - Moringa pods are a much loved vegetable in S India, the mature seed oil is a very quality cosmetic ingredient
  - Moringa leaves have a protein content of 23-25% in dry matter, high protein quality
- Higher leaf and pod yields compared to existing varieties
- High CO<sub>2</sub> sequestration potential, depending on cultivation model



## Proposed addition: Sweet Sorghum

- C4 crop with low input requirements and accumulates high levels of sugars in its stalks.
- Drought tolerant
- Grains can be used as a gluten-free substitute of wheat or corn flour.
- Sugar-rich stem juice can be used for ethanol production
- By-products used as biomass feedstock for various purposes
- 1 t/ha grain yield plus >4 tons of ethanol yield per ha per 115 day crop



# Thank you for your attention

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Additional information

## Products and services

- ▶ Jatropower maintains a diverse jatropha genotype collection that represents the global genetic diversity of the species available in all jatropha hotspots in the world
- ▶ The company's main products are its elite jatropha seeds. Two main lines of jatropha seeds are under development
  - ▶ Conventional jatropha elite seeds to facilitate production of new generation fuel and industrial feedstock production
  - ▶ Edible jatropha varieties for edible vegetable oil and plant proteins from less optimal soil conditions
- ▶ Site assessment for suitability of jatropha cultivation
- ▶ Cultivation techniques for efficient agronomic management of jatropha plantations
- ▶ Robust processing techniques for edible and non-edible jatropha seeds
- ▶ Subsidiary crops to increase crop diversity when desired by customers

# Jatropha curcas seeds in portfolio

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- ▶ Jatropower has several elite jatropha cultivars and hybrids currently in its portfolio
- ▶ Details can be obtained from:
  - ▶ [Non-Edible High Performance Jatropha – Elite cultivars - Jatro Power](#)
  - ▶ [Non-Edible High Performance Jatropha – F1 Hybrids - Jatro Power](#)
  - ▶ [Edible High Performance Jatropha - Jatro Power](#)
- ▶ Jatropower's proposed climate solution “**Jatropha F1 Hybrid Seeds for New Generation Fuel Production**” has been one of the early selections to the elite “**1000 Solutions to protect the environment**” of the Solar Impulse Foundation, Switzerland. More details at <https://solarimpulse.com/efficient-solutions/jph1-seeds>
- ▶ The same solution has been selected as one among 5 climate solutions (out of over 360 solutions) by the International Finance Corporation (IFC) for pitching to global investors

## Seed production capabilities

- Selection, hybridisation and testing on own research farms
- Testing also on client projects, with their consent
- JP operates 5 isolated seed production farms at its station in India for commercial seed production
- Scaling up of production facilities based on demand possible
- Experience in supplying seeds and technology, mainly to clients in India and diverse African countries



## Other Jatropha species available at the farm for crossing trials

- ▶ *Jatropha gossypifolia*
- ▶ *Jatropha mahafalensis*
- ▶ *Jatropha glandulifera*
- ▶ *Jatropha integerrima*
- ▶ *Jatropha pandurifolia*
- ▶ *Jatropha platyphylla*



## Publication list

1. [Francis, G., Makkar, H.P.S., Carle, R. et al. Critique on conclusions regarding toxic compounds in Jatropha curcas kernel cake. Nature Commun Biol 4, 1348 \(2021\). <https://doi.org/10.1038/s42003-021-02869-6>](https://doi.org/10.1038/s42003-021-02869-6)
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