Quality ranking of energy crop plantations-methodology developed for *Jatropha curcas*

Sumit Sarkar
Head (Business Operations), Indian Oil-CREDA Biofuels Limited, India

Abstract: The constraints for a economically feasible biofuel crop plantation is to assess the critical factor of plant growth and estimated yield at various ages of plants. The GoI's ambitious plan of producing sufficient biodiesel by fiscal 2011-12 to meet its mandate of 20 percent blending is looking unattainable given the doubt prevailing amongst plantation growers regarding its yield. As you are aware, that *Jatropha curcas* is a plant species which started its journey towards domestication recently. Like with any other crop this journey started with a number of empirical observations on key factors that influence the successful establishment and growth of Jatropha trees. These early efforts to understand the new crop have in some instances been supported with scientific experiments. This effort resulted in the current knowledge platforms amongst the professionals around agronomy and crop-management. A study has been conducted by researchers to standardize a methodology based on certain quality parameters of Jatropha plantation and rank it according to its yield probability.

Keywords: *Jatropha curcas,* Energy, Crop Plantation

Introduction

Biofuel plantations:

In general, the financial viability of a biodiesel project is based on the performance of energy crop plantations. In case of biofuel crop plantations, regional differences in terms of yields as well as the scale of the plantation critically affect the financial viability and profitability of the projects. Several agronomic and environmental factors influence the plant growth during initial phases of establishment.

State policies:

Jatropha plantation is a subject for state governments. The GOI's ambitious plan of producing sufficient biodiesel by fiscal 2011/12 to meet its mandate of 20-percent blending with diesel is looking unattainable given the unavailability of sufficient feedstock (Jatropha seeds) and lack of sufficient research and development to evolve high-yielding, drought-tolerant Jatropha seeds. According to one estimate, 3.21 million tons of biodiesel would be required from 3.42 million hectares to meet 5-percent blending by Fiscal 2011/12. Considering *Jatropha* to be a major feedstock for biodiesel with an average seed yield of 2.5 tons/hectare and 30 percent biodiesel recovery rate, 18.6 million hectares would need be brought under jatropha cultivation to meet the 20-percent blending target by 2017 (USDA, 2012).

Jatropha curcas plantation:

Public-sector petroleum companies and private-sector firms have entered into memoranda of understanding with state governments to establish and promote Jatropha plantation on government Waste lands or to contract with small and medium farmers. However, only a few states have been able to promote actively Jatropha plantation despite the government's incentives and encouraging policies. Most of the planters are facing the problem of uncertainty of seed yield of Jatropha. Slow progress in Jatropha planting has resulted in lower availability of Jatropha seeds to be used as feedstock for biodiesel production and hence most of the biodiesel units are not operational most of the year.

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*Corresponding Author:
  Mr. Sumit Sarkar,
  Head (Business Operations),
  Indian Oil-CREDA Biofuels Limited, India.

The consequence of this renewed strategy is that we have in the first place to focus our efforts to professionalise the farming of Jatropha with proper quality checks.

Defining Methodology for plant growth:
A study has been conducted by researchers to standardize the quality parameters of Jatropha plantation and rank it according to its yield probability.

The below table will be used to establish a quality ranking based on the observations (Table.1). This quality ranking will be included in the excel file with the extracts from the database. The quality scoring was based on a production capacity of 3.0 t/ha (1.2 kg per plant) through number of branches, mortality, weeds incidence and pest and disease incidence. The production capacity is assessed through the number of branches of the Jatropha Plant, which with a number of assumptions would indicate the yield potential. Of course there are more factors influencing the production potential, besides branching, such as male-female flower ratio, pollination, soil fertility, and climatical impact. For now the branching has been used as an indicator basis for the production potential.

A plantation is good when scored 100 regarding the branches criteria and when not ranked negative for more than 1 of the other criteria (Overall score ≥ 90).

A plantation is average when scored 85 regarding the branches criteria and no more than 1 of the other criteria is given a value of "-10". A plantation can also be average when scored 100 regarding the branches criteria and when more than 1 of the other criteria is given a value of "-10" (Overall score < 90 and > 70).

A plantation is poor when ranked 0 regarding the branches criteria. A plantation can also be given a poor score when scored 85 or 100 regarding the branches criteria and when more than 2 of the other criteria is given a value of "-10" (Overall score ≤70).

Table.1: Quality Scores and ranking for plantations

Quality Score/criteria						
	BRANCHES	**Score**	**BRANCHES**	**Score**	**BRANCHES**	**Score**
(0.5 -1 year)	≥ 3 branches		≥2 and <3 branches		< 2 branches	
1- 2 years old	≥ 9 branches		≥3 and < 9 branches		< 3 branches	
2-3 years old	≥ 27 branches		≥9 and <27 branches		< 9 branches	
3-4 years old	≥ 81 branches	100	≥27 and <81 branches	85	< 27 branches	0
4-5 years old	≥ 90 branches		≥81 and <90 branches		< 81 branches	
> 5 year old	≥ 100 branches		≥90 and <100 branches		< 90 branches	
MORTALITY	< 15%	0	≥15% but <25%	-6	≥25%	-10
PEST/DISEASE (score every pest or disease separately)	No/Low	0	Medium	-6	High	-10
WEEDS	No weeds compete with Jatropha trees	0	Weeds compete with less than 10% of the trees	-6	Weeds compete with more than 10% of the trees	-10
	Plantation is **Good** when score ≥ 90		Plantation is **average** when score < 90 and > 70		Plantation is **poor** when score ≤70	

Grain yield: a calculation

Parameters	Assumptions	Requirements
Grain Yield (kg/ha)	--	3000
No. of Plants	2500	
Grain per plant (kg)		1.2
Grain per kg	1500	
Grains per plants (#)		1800
Avg. Grains per fruit	2.5	
Fruits/plant		720
Avg. Fruits per cluster (#)	8.0	
Cluster/plant (#)		90
Avg. Cluster per branch	1.0	
Branches per plants		90
Productive Branches (%)	90	
Actual Branches per plant		**99≈ 100**

Table: Incidence level for all pests and diseases

Amount	Details
No	No trees affected/20 trees
Low	1 tree affected/20 trees
Medium	2-3 trees affected/20 trees
High	> 3 trees affected/20 trees

Weed infestation level: Degree of direct competition of weeds with Jatropha. Assess incidence on 20 trees, on the same trees as observed for the production parameters.

Table.2. Infestation level of weeds

Amount	Details
No	No trees affected/20 trees
Low	1 tree affected / 20 trees
Medium	2 trees affected/20 trees
High	> 2 trees affected/20 trees

Parameter List

Field name	Description	Units
Add_village	Village name	
Add_Tehsil/Block	Tehsil/Block name	
Add_district	District name	
Add_state	State name	
Elevation	The elevation of a geographic location is its height above a fixed reference point, often the mean sea level. Write the reading from the GPS equipment	Meter
Latitude	GPS co-ordinates- is measured in decimal degrees, positive latitudes are north of the equator, negative latitudes are south of the equator.	DD
Longitude	GPS co-ordinates is measured in decimal degrees Positive longitudes are east of Prime Meridian, negative longitudes are west of the Prime Meridian.	DD
Month and year of planting	Month and year that seedlings were planted in the field	Month
Spacing	Distance between plant to plant and rows to row	Meter
Mortality Rate	Percentage plants dead or absent in block calculated as per Data Recording Sheet	%
Mortality Remarks	Give reason for mortality rate: pest, disease, moisture stress, , mechanical damage, water logging, unknown, and others	
Number of trees flowering	Number of flowering trees observed out of 20 observation trees. A flowering tree is one which has at least one complete open inflorescence.	
Number of trees fruiting	Numbering of fruiting trees observed out of 20 observation trees. A fruiting tree is one which has at least one fruit bunch.	
Planting material	Type of planting material used e.g. seed, seedling, truncheon, hard cutting, and soft cutting.	
Source of planting material	Source of seed, seedling, truncheon, hard cutting, and soft cutting providing agency	
Source planting material ID	Seedling batch number if indicated	
Soil Texture	A simple way to determine soil type / structure is to place soil in your hand add a little water and rub hands together soil type can be observed by referring to description below Choose between: **sandy**: Soil forms a stick but breaks when bent **loamy**: Stick will bend a little before breaking **clay**: Soil forms a stick and will bend **laterite**: Soil red in colour with small rocks **Black soil**: The soil black in colour forms a stick and will bend	
Land form	Plan, Undulated, Hilly	
Irrigation number in a year	Write total number of irrigation given to the crop in a year	Number

Earthing up & basin formation	Write Month and Year (mm/ccyy) of earthing up)	
Pruning	Choose from last observed practice: No pinching/pruning Improper pinching/pruning Pinching First pinching Second Pruning Third Pruning Maintenance pruning follows(Keeping plant at workable height)	
Month & Year of last pruning/pinching	Should be noted month and year (mm/ccyy) indicated	
Date of Collection	The date when data collection is conducted. The format should be Date/Month/Year, dd/mm/ccyy (for e.g. 13/05/2007)	Date
Quarter	The quarter when data collection is conducted: Q1, Q2, Q3, Q4	
Number of branches	Number of branches observed on 20 observed trees. A branch is the lateral vegetative growth of tissues either from main stem or its subsidiaries of a plant which comes out from the internodes and has a growing tip and has the potential to bear flowers/fruits.	No
Number of inflorescence	Number of inflorescence observed on 20 observed trees.	No
Number of fruits	Number of fruits observed on the 20 observed tree. A fruit is a ripened ovary with seeds.	No
Number of fruit bunches	Total number of fruit bunches observed on 20 observed tree. A fruit bunch is a group of fruits on one inflorescence.	No
Plant height	Height of the (Canopy of the) tree in *cm without decimals*	

Format data sheet:

Field name	Description
Date of Data Collection	
Quarter	
Year	
Zone	
Cluster Number	
Plot /Village	
Tehsil/Block	
District	
State	
Crop Area	
Elevation	
Latitude	
Longitude	
Month and year of planting	
Plantation Spacing	
Planting material	
Source of planting material	
Soil texture	
Land form	
Irrigation number in a year	
Earthing up	
Pruning	
Month & Year of pruning	

Physiological data to be taken on 20 randomly selected trees in a plot

Traits	Avg	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10
Plant height (cm)											
Plant width (cm)											
# branches											
# of flower											
# fruits											
# fruit bunches											

Pest, diseases, nutrient deficiency status

(# of trees infected on 20)	Observation on tree (Pl. tick)										Status*	
	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10	Low	Med
Nutritional Def.												
Drainage Problem												
Scutellarid bug												
Leaf Webber												
Yellow mite												
Leaf miner												
Thrips												
Mealy bug												
Termite												
Powder mildew												
Wilt												
Collar rot												
Root rot												
Leaf spot												
Leaf blight												
Virus												
Weed competition												
Others												

*refer Table 1 and 2 of plant health data recording procedure

Randomly Select 20 line of 10 plants each in the selected plot and put number of trees found dead or absent against each randomly selected line

Traits	Line 1	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7	Line 8	Line 9	Line 10	Mortality %
No. of plants dead/absent											0

Conclusion

The effort towards developing quality ranking of energy crop plantations particularly for *Jatropha curcas* is aimed to sustain and enhance economical Jatropha crop production by transferring the sound, research-derived knowledge to farmers which will result in the economical production of Jatropha curcas grains with high oil yield and the preservation of environmental quality during Jatropha curcas grain production.

Acknowledgement

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