

Integrated Crop Management Ve

ISSN 1020-4555

Jatropha: A Smallholder Bioenergy Crop The Potential for Pro-Poor Development



Integrated Crop Management Vol. 8-2010

Jatropha: A Smallholder Bioenergy Crop

The Potential for Pro-Poor Development

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ISBN 978-92-5-106438-2

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FOREWORD

As developing countries face increasing local demand for energy in rural areas, they also must deal with both economic and environmental pressure on agricultural lands in general. The possibility of growing energy crops such as *Jatropha curcas* L. has the potential to enable some smallholder farmers, producers and processors to cope with these pressures.

Jatropha is an underutilized, oil-bearing crop. It produces a seed that can be processed into non-polluting biodiesel that, if well exploited, can provide opportunities for good returns and rural development. In addition to growing on degraded and marginal lands, this crop has special appeal, in that it grows under drought conditions and animals do not graze on it.

However, many of the actual investments and policy decisions on developing jatropha as an oil crop have been made without the backing of sufficient science-based knowledge. Realizing the true potential of jatropha requires separating facts from the claims and half-truths.

This review is based on the records of the International Consultation on Pro-Poor Jatropha Development held in April 2008, in Rome, Italy, and hosted by the International Fund for Agricultural Development (IFAD), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Foundation (UNF) and the Prince Albert II of Monaco Foundation. The consultation was designed to support activities aimed at developing appropriate technologies for sustainable intensification of biofuel feedstock production, studying the economics of bioenergy for rural needs and assessing its impact on rural poverty.

The review provides a brief overview of biofuels, their growth drivers and their potential impacts on poor societies. It looks at how jatropha, which originated in Central America and then spread across Africa and Asia, has become widespread throughout the tropics and subtropics. It also builds upon technical and scientific information on key issues affecting jatropha for pro-poor development that was presented during the Consultation by specialists from around the world.

The review also summarizes the most recent data on the cultivation, seed harvesting and processing, uses and genetic improvement of



jatropha, and it offers an overview and case studies of experiences with jatropha production in sub-Saharan Africa and South Asia. It concludes with viewpoints gathered from the Consultation's group discussions and roundtables that recognized the importance of biofuels and the potential of jatropha biofuel development for poverty reduction, but also emphasized the need to consider potential risks to food security, the environment and livelihoods of the rural poor.

This publication seeks to contribute to strengthening jatropha policies and strategies in developing countries – policies that recognize the potential of jatropha to contribute towards pro-poor development, sustain rural income and improve livelihoods. We trust that it will provide valuable guidance to government and institutional policy- and decision-makers, and that it will be a valuable source of information for programme managers, international and multilateral development organizations, donors, NGOs, the private sector and foundations as well as researchers, advisors, teachers and professionals in agriculture.

Shivaji Pandey Director, Plant Production and Protection Division Food and Agriculture Organization of the United Nations

Rodney Cooke

Director, Technical Advisory Division International Fund for Agriculture Development



The papers and presentations given at the International Consultation on Pro-Poor Jatropha Development held on 10-11 April 2008 in Rome, Italy, form the essential core of this manuscript. The valuable contributions made at this forum by many individual participants are very much acknowledged.

Information and clarification on a number of issues were sought from Reinhard K. Henning, jatropha consultant, and Amir Kassam, FAO consultant. Their reviews of the draft undoubtedly contributed to the quality of the final manuscript.

While the photographs in the text are separately attributed, we would like to thank those who freely gave permission for their reproduction, namely: Godofredo U. Stuart Jr, Reinhard K. Henning, Tom Burrell (Mali-Folkecentre), Lode Messemaker, Subhas Wani (ICRISAT), Hong Yan (Temasek).

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Particular thanks are due to NeBambi Lutaladio, FAO Plant Production and Protection Division, for initiating this publication and Richard Brittaine, FAO consultant, for writing the manuscript. Thanks also to Nancy Hart, who edited the final manuscript, and Joanne Morgante, who designed the publication. All of their efforts and dedication made possible the release of this publication.

Eric A. Kueneman Deputy Director FAO Plant Production and Protection Division Vineet Raswant Senior Technical Adviser International Fund for Agriculture Development





CONTENTS

vAcknowledgementsxAcronyms and AbbreviationsxiiiExecutive SummaryCHAPTER 11Introduction2Biofuels - an Overview2Bioenergy and biofuels3Bioethanol and biodiesel4Straight vegetable oil4Growth drivers of biofuels5Climate change6The importance of the transport sector7Production and consumption8The inpacts of biofuels and their sustainability10Energy poverty and bioenergy in poor societies12Jatropha – global and regional production and trends13Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha18Livestock barrier and land demarcation18Fuelwood19Support for vanilla19Green manure19Plant extracts19Stem	iii	Foreword
xiiExecutive SummaryCHAPTER 1IntroductionBiofuels - an OverviewBioenergy and biofuelsFirst, second and third generation biofuelsBioethanol and biodieselStraight vegetable oilGrowth drivers of biofuelsClimate changeClimate changeEnergy securityRural developmentThe importance of the transport sectorProduction and consumptionThe impacts of biofuels and their sustainabilityEnergy poverty and bioenergy in poor societiesJatropha – global and regional production and trendsCHAPTER 2Jatropha curcas L.Origin and spreadNomenclature and taxonomyDescriptionThe jatropha treeFresion control and improved water infiltrationLivestock barrier and land demarcationFuelwoodSupport for vanillaPlant extracts	V	Acknowledgements
CHAPTER 11Introduction2Biofuels – an Overview2Bioenergy and biofuels3Bioethanol and bindigeneration biofuels3Bioethanol and biodiesel4Straight vegetable oil4Growth drivers of biofuels5Climate change5Energy security5Rural development6The importance of the transport sector7Production and consumption8The impacts of biofuels and their sustainability10Energy poverty and bioenergy in poor societies12Jatropha – global and regional production and trendsCHAPTER 21313Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha17The jatropha tree17Erosion control and improved water infiltration18Fuelwood19Support for vanilla19Plant extracts	Х	Acronyms and Abbreviations
1Introduction2Biofuels – an Overview2Bioenergy and biofuels3Bioenergy and biofuels4First, second and third generation biofuels3Bioethanol and biodiesel4Straight vegetable oil4Growth drivers of biofuels5Climate change5Energy security5Rural development6The importance of the transport sector7Production and consumption8The impacts of biofuels and their sustainability10Energy poverty and bioenergy in poor societies12Jatropha – global and regional production and trends13Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha tree17Erosion control and improved water infiltration18Livestock barrier and land demarcation18Fuelwood19Green manure19Plant extracts	xii	Executive Summary
1Introduction2Biofuels – an Overview2Bioenergy and biofuels3Bioenergy and biofuels4First, second and third generation biofuels3Bioethanol and biodiesel4Straight vegetable oil4Growth drivers of biofuels5Climate change5Energy security5Rural development6The importance of the transport sector7Production and consumption8The impacts of biofuels and their sustainability10Energy poverty and bioenergy in poor societies12Jatropha – global and regional production and trends13Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha tree17Erosion control and improved water infiltration18Livestock barrier and land demarcation18Fuelwood19Green manure19Plant extracts		
 Biofuels – an Overview Bioenergy and biofuels First, second and third generation biofuels Bioethanol and biodiesel Straight vegetable oil Growth drivers of biofuels Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description The jatropha tree Frosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 		CHAPTER 1
 Bioenergy and biofuels First, second and third generation biofuels Bioethanol and biodiesel Straight vegetable oil Growth drivers of biofuels Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description The jatropha tree Frosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	1	Introduction
 First, second and third generation biofuels Bioethanol and biodiesel Straight vegetable oil Growth drivers of biofuels Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description The jatropha tree Frosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	2	Biofuels – an Overview
 Bioethanol and biodiesel Straight vegetable oil Growth drivers of biofuels Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	2	Bioenergy and biofuels
 Straight vegetable oil Growth drivers of biofuels Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	2	First, second and third generation biofuels
 Growth drivers of biofuels <i>Climate change</i> <i>Energy security</i> <i>Rural development</i> The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 <i>Jatropha curcas</i> L. Origin and spread Nomenclature and taxonomy Description <i>Uses of Jatropha tree</i> <i>Erosion control and improved water infiltration</i> <i>Livestock barrier and land demarcation</i> <i>Fuelwood</i> <i>Support for vanilla</i> <i>Green manure</i> <i>Plant extracts</i> 	3	Bioethanol and biodiesel
 Climate change Energy security Rural development The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	4	Straight vegetable oil
 <i>Energy security</i> <i>Energy security</i> <i>Rural development</i> The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 <i>Jatropha curcas</i> L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha tree <i>The jatropha tree</i> <i>Erosion control and improved water infiltration</i> <i>Livestock barrier and land demarcation</i> <i>Fuelwood</i> Support for vanilla <i>Green manure</i> <i>Plant extracts</i> 	4	Growth drivers of biofuels
5Rural development6The importance of the transport sector7Production and consumption8The impacts of biofuels and their sustainability10Energy poverty and bioenergy in poor societies12Jatropha – global and regional production and trends12CHAPTER 213Jatropha curcas L.13Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha17The jatropha tree17Erosion control and improved water infiltration18Fuelwood19Support for vanilla19Plant extracts	5	Climate change
 The importance of the transport sector Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha tree <i>Erosion control and improved water infiltration</i> <i>Livestock barrier and land demarcation</i> <i>Fuelwood</i> Support for vanilla Green manure Plant extracts 	5	Energy security
 Production and consumption The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Fielwood Support for vanilla Green manure Plant extracts 	5	Rural development
 The impacts of biofuels and their sustainability Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	6	The importance of the transport sector
 Energy poverty and bioenergy in poor societies Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	7	Production and consumption
 Jatropha – global and regional production and trends CHAPTER 2 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	8	The impacts of biofuels and their sustainability
CHAPTER 213Jatropha curcas L.13Origin and spread14Nomenclature and taxonomy15Description17Uses of Jatropha17The jatropha tree17Erosion control and improved water infiltration18Livestock barrier and land demarcation18Fuelwood19Support for vanilla19Green manure19Plant extracts	10	Energy poverty and bioenergy in poor societies
 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 	12	Jatropha – global and regional production and trends
 Jatropha curcas L. Origin and spread Nomenclature and taxonomy Description Uses of Jatropha The jatropha tree Erosion control and improved water infiltration Livestock barrier and land demarcation Fuelwood Support for vanilla Green manure Plant extracts 		
 13 Origin and spread 14 Nomenclature and taxonomy 15 Description 17 Uses of Jatropha 17 The jatropha tree 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 		CHAPTER 2
 14 Nomenclature and taxonomy 15 Description 17 Uses of Jatropha 17 The jatropha tree 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	13	Jatropha curcas L.
 15 Description 17 Uses of Jatropha 17 The jatropha tree 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	13	Origin and spread
 17 Uses of Jatropha 17 The jatropha tree 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	14	Nomenclature and taxonomy
 17 The jatropha tree 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	15	Description
 17 Erosion control and improved water infiltration 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	17	Uses of Jatropha
 18 Livestock barrier and land demarcation 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	17	The jatropha tree
 18 Fuelwood 19 Support for vanilla 19 Green manure 19 Plant extracts 	17	Erosion control and improved water infiltration
 Support for vanilla Green manure Plant extracts 	18	Livestock barrier and land demarcation
19Green manure19Plant extracts	18	Fuelwood
19 Plant extracts	19	Support for vanilla
	19	Green manure
19 Stem	19	Plant extracts
	19	Stem



- 19 Bark and roots
- 20 Leaves
- 20 Seeds
- 20 Fruits and seeds
- 20 Toxicity and invasiveness
- 20 *Toxicity*
- 22 Invasiveness

CHAPTER 3

27	Jatropha cultivation
27	Climate
28	Soils
29	Propagation and crop establishment
30	Vegetative propagation using cuttings
30	Propagation from seed
33	Planting
33	Intercropping

- 34 Crop maintenance
- 35 Plant nutrition
- 36 Water requirements
- 37 Pests and diseases
- 39 Seed yields

CHAPTER 4

41	Seed harvest, processing and uses of Jatropha
42	Harvesting
43	Oil extraction
45	Properties of Jatropha oil
46	Uses of Jatropha oil
46	Jatropha oil as a biodiesel feedstock
48	Pure jatropha oil
49	Cooking fuel
50	Lighting fuel
50	Soap making
50	Other uses for the oil
51	Properties and uses of the seed cake
51	Livestock feed



51 52 52	Organic fertilizer Fuel Using the fruit shells and seed husks
	CHAPTER 5
55	Genetic improvement
55	Present status
56	The importance of yield
56	Production oriented breeding objectives
57	Pro-poor breeding objectives
57	Producing improved varieties of <i>Jatropha curcas</i>
59	Breeding goals
	CHAPTER 6
60	Experience of Jatropha in sub-Saharan Africa and South Asia
61	West Africa – Mali
61	Jatropha system project
64	Multifunctional platform project
65	East Africa – Tanzania
65	Jatropha seed production
66	Production of jatropha oil
67	Soap production
69	Use of jatropha oil
72	Asia – India
72	Community scheme wasteland development
	CHAPTER 7
77	Jatropha for pro-poor development
77	Biofuels – an opportunity for the rural poor
79	Characterization of Jatropha production systems
82	Jatropha – an opportunity for the rural poor in semi-arid regions
82	Opportunities for poverty reduction
84	Economic risks
85	Environmental risks
86	Risks to society
87	Policy conclusions
90	REFERENCES

Vol. 8–2010 ix



JATROPHA: A SMALLHOLDER BIOENERGY CROP

ACRONYMS AND ABBREVIATIONS

B5	Blend of 5 percent biodiesel with mineral diesel
Ca	Calcium
CDM	Clean development mechanism
CGIAR	Consultative Group on International Agricultural
	Research
CO,	Carbon dioxide
CPR	Common property resource
Cu	Copper
DAP	Diammonium phosphate
DM	Dry matter
DWMA	District Water Management Agency
E5	Blend of 5 percent bioethanol with petrol
EMPPO	European and Mediterranean Plant Protection Organization
ET	Evapotranspiration
ETBE	Ethyl Tertiary Butyl Ether
FACT	Fuels from Agriculture in Communal Technology
FAO	Food and Agriculture Organization of the United
	Nations
Fe	Iron
GDP	Gross Domestic Product
GHG	Greenhouse gas
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HH	Household
ICRISAT	International Crops Research Institute for the Semi-
	Arid Tropics
IFAD	International Fund for Agricultural Development
JME	Jatropha methyl ester
Κ	Potassium
K ₂ O	Potassium oxide
Kcals	Kilocalories
Kg	Kilogram
1 3377	
kW	Kilowatt
kw LCA LIFDC	Kilowatt Life cycle analysis Low-income food-deficit country



MED	Multifue at a latefue
MFP	Multifunctional platform
Mg	Magnesium
mg	Milligram
MJ	Megajoule
Mn	Manganese
Ν	Nitrogen
N_2O	Nitrous oxide
n.d.	No date
NGO	Non-governmental organization
NOVOD	National Oilseeds and Vegetable Oils Development
	Board
OECD	Organisation for Economic Co-operation and Development
Р	Phosphate
RME	Rape methyl ester
R	Indian rupee
S	Sulphur
SSP	Single super phosphate
SVO	Straight vegetable oil
TZS	Tanzanian shillings
ULSD	Ultra low sulphur diesel
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
VOME	Vegetable oil methyl ester
Zn	Zinc



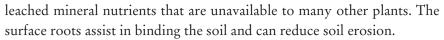
EXECUTIVE SUMMARY

Declining reserves of fossil fuels plus recognition that growing carbon dioxide emissions are driving climate change have focused world attention on the need to reduce fossil fuel dependence. In turn, this has increased interest in promoting bioenergy, including biofuels, as a renewable energy source.

Liquid biofuels have the potential to help power the transportation sector. Considering that transportation is responsible for some 30 percent of current energy usage and that biofuels can be used in transportation with only few changes to the existing distribution infrastructure, biofuels become an extremely important form of bioenergy. Producing liquid biofuels from food crops using conventional technology is also being pursued as a means of farm income support and for driving rural development. However, the debate around biofuels is creating a lot of uncertainty and will continue to do so until it can be shown that biofuels can be low-cost, low-carbon and sustainable, and do not endanger food security.

Given the sheer size of the energy market compared to the market for agricultural commodities, the potential for biofuels alone to address climate change and energy security is quite limited. However, the increased demand for biofuels does create a huge new market for agricultural products. Liquid biofuels generally require large-scale production and processing to be viable, although this is less true where the end product is straight vegetable oil rather than either bioethanol or biodiesel.

Interest in *Jatropha curcas* as a source of oil for producing biodiesel has arisen as a consequence of its perceived ability to grow in semi-arid regions with low nutrient requirements and little care. The seed typically contains 35 percent oil which has properties highly suited to making biodiesel. Unlike other major biofuel crops, jatropha is not a food crop since the oil is non-edible and is, in fact, poisonous. It is a low growing oil-seed-bearing tree that is common in tropical and subtropical regions where the plant is often used in traditional medicine and the seed oil is sometimes used for lighting. The tree is occasionally grown as a live fence for excluding livestock and for property demarcation. The rooting nature of jatropha allows it to reach water from deep in the soil and to extract



In 2008, jatropha was planted on an estimated 900 000 ha globally – 760 000 ha (85 percent) in Asia, followed by Africa with 120 000 ha and Latin America with 20 000 ha. By 2015, forecasts suggest that jatropha will be planted on 12.8 million ha. The largest producing country in Asia will be Indonesia. In Africa, Ghana and Madagascar will be the largest producers. Brazil will be the largest producer in Latin America.

Jatropha has a number of strengths: the oil is highly suitable for producing biodiesel but can also be used directly to power suitably adapted diesel engines and to provide light and heat for cooking, it is fast growing and quick to start bearing fruit, and the seed is storable making it suited to cultivation in remote areas. Jatropha could eventually evolve into a high yielding oil crop and may well be productive on degraded and saline soils in low rainfall areas. Its by-products may possibly be valuable as fertilizer, livestock feed, or as a biogas feedstock, its oil can have other markets such as for soap, pesticides and medicines, and jatropha can help reverse land degradation.

Jatropha's chief weaknesses relate to the fact that it is an essentially wild plant that has undergone little crop improvement. Its seed yields, oil quality and oil content are all highly variable. Most of the jatropha currently grown is toxic which renders the seedcake unsuitable for use as livestock feed and may present a human safety hazard. Fruiting is fairly continuous which increases the cost of harvesting. Knowledge of the agronomy of jatropha and how agronomic practices contribute to yield is generally lacking. Furthermore, there is an unknown level of risk of *Jatropha curcas* becoming a weed in some environments.

Optimum growing conditions are found in areas of 1 000 to 1 500 mm annual rainfall, with temperatures of 20°C to 28°C with no frost, and where the soils are free-draining sands and loams with no risk of waterlogging. Propagation is typically from seed. Cuttings offer the benefit of uniform productivity with the disadvantage that they do not generally develop a tap root. The production of clonal and disease-free plants using tissue culture is not yet a commercial reality. Attention to crop husbandry and adequate nutrition and water are essential to achieving high yields. Pruning is important to increase the number of flowering branches. Crop improvement is at an early stage. Increasing oil yield must be a priority – an objective that has only recently been addressed by private enterprise. Genetic variation among known *Jatropha curcas* accessions may be less than previously thought, and breeding inter-specific hybrids may offer a promising route to crop improvement. Jatropha displays considerable genetic–environment interaction, meaning that different clones may appear and perform very differently under different environmental conditions. Short-term goals should aim at producing superior clonal plants using cuttings and/or cell culture techniques, with longer term goals aimed at developing improved varieties with reliable trait expression and with a seed production system that ensures farmer access to productive and reliable planting materials.

In terms of its viability as a cash crop, experience with jatropha production in sub-Saharan Africa and South Asia has found that yields are marginal, at best. Reported yields have been between 1 and 1.6 tonnes per ha. Holistic schemes that embrace jatropha production, oil extraction and utilization in remote rural communities appear the most viable, particularly where its other benefits are recognized, such as reversing land degradation. Jatropha production systems can be characterized in terms of their direct or indirect potential contribution to pro-poor development. It is expected that large plantations developed by the private sector will predominate in the future and that smallholders may be contract farmers for such commercial enterprises.

Jatropha biofuel production could be especially beneficial to poor producers, particularly in semi-arid, remote areas that have little opportunity for alternative farming strategies, few alternative livelihood options and increasing environmental degradation. While there are various possibilities for utilizing the by-products of jatropha – which would add value for the producers and reduce the carbon cost of the oil as a biofuel – there is an important trade-off between adding value and utilizing the byproducts as soil ameliorants to reverse land degradation. Local utilization of jatropha oil is one of a number of strategies that may be used to address energy poverty in remote areas and could be part of production systems or part of a "living fence" to control livestock grazing.

The expectation that jatropha can substitute significantly for oil imports will remain unrealistic unless there is an improvement in the genetic



potential of oil yields and in the production practices that can harness the improved potential. For the present, the main pro-poor potential of jatropha is within a strategy for the reclamation of degraded farmland along with local processing and utilization of the oil and by-products. In addition, by providing physical barriers, jatropha can control grazing and demarcate property boundaries while at the same time improving water retention and soil conditions. These attributes, added to the benefits of using a renewable fuel source, can contribute in an even larger way to protecting the environment.

