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Optimization of the Jatropha curcas Supply Chain as a Criteria for the Implementation of Future Collection Points in Rural Areas of Manabi-Ecuador

Authors : Boris G. German, Edward Jiménez, Sebastián Espinoza, Andrés G. Chico, Ricardo A. Narváez

Abstract : The unique flora and fauna of The Galapagos Islands has leveraged a tourism-driven growth in the islands. Nonetheless, such development is energy-intensive and requires thousands of gallons of diesel each year for thermoelectric electricity generation. The needed transport of fossil fuels from the continent has generated oil spillages and affectations to the fragile ecosystem of the islands. The Zero Fossil Fuels initiative for The Galapagos proposed by the Ecuadorian government as an alternative to reduce the use of fossil fuels in the islands, considers the replacement of diesel in thermoelectric generators, by Jatropha curcas vegetable oil. However, the Jatropha oil supply cannot entirely cover yet the demand for electricity generation in Galapagos. Within this context, the present work aims to provide an optimization model that can be used as a selection criterion for approving new Jatropha Curcas collection points in rural areas of Manabi-Ecuador. For this purpose, existing Jatropha collection points in Manabi were grouped under three regions: north (7 collection points), center (4 collection points) and south (9 collection points). Field work was carried out in every region in order to characterize the collection points, to establish local Jatropha supply and to determine transportation costs. Data collection was complemented using GIS software and an objective function was defined in order to determine the profit associated to Jatropha oil production. The market price of both Jatropha oil and residual cake, were considered for the total revenue; whereas Jatropha price, transportation and oil extraction costs were considered for the total cost. The tonnes of Jatropha fruit and seed, transported from collection points to the extraction plant, were considered as variables. The maximum and minimum amount of the collected Jatropha from each region constrained the optimization problem. The supply chain was optimized using linear programming in order to maximize the profits. Finally, a sensitivity analysis was performed in order to find a profit-based criterion for the acceptance of future collection points in Manabi. The maximum profit reached a value of $ 4,616.93 per year, which represented a total Jatropha collection of 62.3 tonnes Jatropha per year. The northern region of Manabi had the biggest collection share (69%), followed by the southern region (17%). The criteria for accepting new Jatropha collection points in the rural areas of Manabi can be defined by the current maximum profit of the zone and by the variation in the profit when collection points are removed one at a time. The definition of new feasible collection points plays a key role in the supply chain associated to Jatropha oil production. Therefore, a mathematical model that assists decision makers in establishing new collection points while assuring profitability, contributes to guarantee a continued Jatropha oil supply for Galapagos and a sustained economic growth in the rural areas of Ecuador.

Keywords : collection points, Jatropha curcas, linear programming, supply chain
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