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Optimization of the Feedstock Supply of an Oilseeds Conversion Unit for Biofuel Production in West Africa: A Comparative Study of the Supply of Jatropha curcas and Balanites aegyptiaca Seeds

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Abstract : Jatropha curcas (jatropha) is the plant that has been the most studied for biofuel production in West Africa. There exist however other plants such as Balanites aegyptiaca (balanites) that have been targeted as a potential feedstock for biofuel production. This biomass could be an alternative feedstock for the production of straight vegetable oil (SVO) at costs lower than jatropha-based SVO production costs. This study aims firstly to determine, through an MILP model, the optimal organization that minimizes the costs of the oilseeds supply of two biomass conversion units (BCU) exploiting respectively jatropha seeds and the balanitès seeds. Secondly, the study aims to carry out a comparative study of these costs obtained for each BCU. The model was then implemented on two theoretical cases studies built on the basis of the common practices in Burkina Faso and two scenarios were carried out for each case study. In Scenario 1, 3 pre-processing locations ("at the harvesting area", "at the gathering points", "at the BCU") are possible. In scenario 2, only one location ("at the BCU") is possible. For each biomass, the system studied is the upstream supply chain (harvesting, transport and pre-processing (drying, dehulling, depulping)), including cultivation (for jatropha). The model optimizes the area of land to be exploited based on the productivity of the studied plants and material losses that may occur during the harvesting and the supply of the BCU. It then defines the configuration of the logistics network allowing an optimal supply of the BCU taking into account the most common means of transport in West African rural areas. For the two scenarios, the results of the implementation showed that the total area exploited for balanites (1807 ha) is 4.7 times greater than the total area exploited for Jatropha (381 ha). In both case studies, the location of pre-processing “at the harvesting area” was always chosen for scenario1. As the balanites trees were not planted and because the first harvest of the jatropha seeds took place 4 years after planting, the cost price of the seeds at the BCU without the pre-processing costs was about 430 XOF/kg. This cost is 3 times higher than the balanites's one, which is 140 XOF/kg. After the first year of harvest, i.e. 5 years after planting, and assuming that the yield remains constant, the same cost price is about 200 XOF/kg for Jatropha. This cost is still 1.4 times greater than the balanites's one. The transport cost of the balanites seeds is about 120 XOF/kg. This cost is similar for the jatropha seeds. However, when the pre-processing is located at the BCU, i.e. for scenario2, the transport costs of the balanites seeds is 1200 XOF/kg. These costs are 6 times greater than the transport costs of jatropha which is 200 XOF/kg. These results show that the cost price of the balanites seeds at the BCU can be competitive compared to the jatropha's one if the pre-processing is located at the harvesting area.

Keywords : Balanites aegyptiaca, biomass conversion, Jatropha curcas, optimization, post-harvest operations
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