Tool for comparative oil crop analysis







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Acronyms and Abbreviations

FACT	Fuels from Agriculture for Communal Technology
APS	Agricultural Production System
RoL	Return on Labour

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1 INTRODUCTION

The FACT Foundation develops innovative projects and technologies to assist local communities in producing their own bioenergy. This enables these communities to save money for fossil fuels, increases energy availability and related business development and has therefore a positive effect on the local economy.

It is worth mentioning that within the FACT strategy, preference is given to available agricultural waste from industries above the land use related production of biomass. However, specific niches exist in which exceptions can be made on this strategy.

Several oil crops are currently under investigation in order to determine their **technical suitability** as an energy crop. Furthermore, oil crop production should be based on a sound **economic** base in order to determine its potential for success.

There is an increasing need for energy and biomass production is an interesting option in order to meet this goal. Production of vegetable oils for the production of liquid fuels is seen as one of this. Nevertheless many experiences of innovative projects on vegetable oil production did not lead to the expected results. This manual serves as background information for the excel sheet 'Oil crop comparative analysis' that was made as a tool for oil crop selection. In case an investor is planning to invest in oil crop production, this sheet will serve as a tool to carry out an economic comparative analysis. Note that parameters can be changed according to the local situation. Previous to this economic comparison a selection should be made based on agricultural, climatic and social factors.

There is a great variation in the way farmers tend their businesses. Because of this, it is impossible to make a generalization in farming practices without sacrificing precision.
Nevertheless an excel sheet was developed on order to compare 17 different (oil) crops based on their economic performance. Every crop is analysed for 3 different agricultural production systems (APS). The systems that are currently presented in this sheet; low input with family labour (APS 1), high input with family labour (APS 2) and high input with hired labour (APS 3) can be viewed as examples. A different system set-up can be made as well. Furthermore the sheet will always be used with local and up to date parameters (fewer estimated values), which increases its value for use.

Two food crops are included as a reference for the economic comparison; these are the common bean and maize. These crops can be used as reference crops in order to adapt the sheet to the local situation, since economic data on bean and maize are widely available. Moreover it will put the economic performance of oil crops in a wider perspective of opportunities.

2 METHODOLOGY

The sheet is developed to compare 17 different (oil) crops for 3 different management scenarios. For every crop that is included in the 'excel analysis tool' a range of agro-climatic requirements has been presented in order to previously select on oil crops compared to the local conditions. Based on the scenarios the productions costs, yields and revenue will vary significantly and gives a first estimation for economic feasibility in the area for which the analysis is carried out. In the 'excel analysis tool' is also suitable to carry out a sensitivity analysis by changing the used parameters for the calculation and compare the effects on the result. Based on a sensitivity analysis one can estimate the reliability of the analysis tool and conclude on the relative effect of changes in costs or revenues. The agricultural practise consisted of various options that can be included or excluded in the analysis by filling in a '0' or a '1' in the required cell.

Direct seeding										
Mechanical	yes=1; no=0	0	0	0	0	0	1	0	0	0
Manual	yes=1; no=0	0	0	0	1	0	0	0	0	0
Seedlings planting										
Mechanical	yes=1; no=0	0	1	1	0	0	0	0	0	1
Manual	yes=1; no=0	1	0	0	0	1	0	1	1	0

Figure 1 with the use of '0' and '1' the user can indicate which activity is included in the crop production system.

Data in the spread sheet were gathered from literature, information from internet of several institutes such as Faostat from FAO, (Purdue University), and several FACT manuals that were prepared recently. In case data were not present and could not be calculated, estimations were made. In a later stage data were presented to crop specialists for a validity check. Several parameters were identified to form the framework of the economic comparison spread sheet. In the next paragraphs these will be explained in short.

2.1 Low input (APS 1)

Low input agriculture is represented by the use of manual labour to accomplish tasks on the field or in the way of preparing for this. Use of high tech inputs such as special fertilizers, the whole range of pesticides, fungicides and insecticides are generally not available or too costly for this way of farming. Farming is generally not done for the market but primarily for subsistence. Further, it is assumed in this production system that labour is provided by the farmer and does not involve any financial activity. The total revue of the low input farming system is expressed in the unit USD/man-day and can be compared to the local minimum wages in order to draw conclusions on the economic feasibility of the activity.

2.2 High input

High input agricultural systems are characterized by the use of production means that represent a financial value. Here we divide high input into two types as explained below.

2.2.1 High input with own labour (APS 2)

A high input agricultural system is characterized by the use of capital as input; fertilizers, a tractor or spraying equipment for pesticides, an irrigation system in case of limited rainfall are used to maximize yield as much as possible. Two types of this system are included in the spread sheet; a high input system wherein the farmer uses family labour to lower labour costs and a high input system in which the farmer owner hires labour to work at the farm.

In this spread sheet the overall wage per day for unskilled labour has been put at 2 USD per day. This is of course a crude estimate, since it differ greatly between countries, and can be adapted per season and the required job to do. Again all parameters can be changed according to the local situation.

2.2.2 High input with hired labour (APS 3)

This production system is representing the most intensive agricultural production method in which input is high, output is high and the labour is all hired. This is a capital and energy intensive production method but higher investments may be compensated by increased yield. This method is only feasible if there is sufficient access to financial resources and agricultural input and when an infrastructure of services for machinery is present.

2.3 Climate and soil type

In the top of the sheet, basic agro climatic requirements for the crops are given in order to preselect on the agricultural feasibility of the oil crop.

Parameter			Unit	Value	
					Low input
Monetary unit			USD		
Interest rate agri loan			%/annum	6%	High Input (F)
					High Input (H)
Labor costs	Unskilled		USD/day	2	
	Semi skilled		USD/day	3	
Labor day			hr/day	8	
		land costs	USD/ha/yr	100	
		precipitation	mm/ha/yr	1500	

		Oil crop								
Parameter	*Unit*	**Coconut**			**Jatropha**			**Oil palm**		
Latin name		*Cocos nucifera*			*Jatropha curcas*			*Elaeis oleifera/guineensis*		
		Low input	High Input (F)	High Input (H)	Low input	High Input (F)	High Input (H)	Low input	High Input (F)	High Input (H)
Climate										
Length of growing season	day/annum	365	365	365	365	365	365	365	365	365
Precipitation in growing season	mm/gr season	1800	1800	1800	600	1000	1000	1800	2000	2000
Humidity growing season								> 85%	> 85%	> 85%
Temperature growing season	Celcius	21 - 30	21 - 30	21 - 30	> 23	> 23	> 23	24 - 28	24 - 28	24 - 28
Soil type										
pH		5.0 - 8.0	5.0 - 8.0	5.0 - 8.0	5.5 - 8.5	5.5 - 8.5	5.5 - 8.5	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0
Texture		sandy	sandy	sandy				loam/clayey	loam/clayey	loam/clayey
OM content										

Figure 2 the oil crop selection tool includes specific data on climate and soil properties

The data used can be adjusted to the specific situation of the region. The *length of the growing* season is the time that a crop is being cultivated on the field. Some crops with a fast lifecycle can thus be cultivated up to three times per year under tropical conditions. The *precipitation* is the total amount of the influx of water into the agricultural system that is available for plant growth. This is especially important in relation to possible irrigation to assess which crops are suited to the local conditions. The amount of precipitation can be entered in the upper part of the sheet according to the climate conditions of the region that is assessed. The *humidity* might form a limitation for certain crops and needs to be assessed in the same way as precipitation. The *temperature* given are the limits within which the specified crop or is able to grow. Short cold or heat spells that might occur are dealt with in this way. These temperature requirements can serve as first selection criteria in order to select a suitable oil crop for the

region. The soil type pH, texture and organic matter content of the soil are several parameters that define the limits within which a species can grow. Some species can be grown under a wide array of conditions; others demand much more specific conditions. Generally the preferred soil conditions are given; in case of less specific conditions the term “broad” will be used.

2.4 Land preparation

Land preparation is the activity done previous to sowing or planting. In this model different methods for land preparation are included that are common for tropical land use practices. Land preparation can be done starting from a situation of bush land. This land is usually prepared according to the non-sustainable slash and burn method. In the model two ways for slash and burn are included; either in a traditional or the modern way: manually or heavy equipment bulldozer and tree cutter. Fortunately land preparation is generally done on previous agricultural. Here again there can be chosen for manually or mechanized land preparation on agri-land. These four options in total, have been included in the model. Estimations have been made of the related cost of these two different preparations.

2.5 Crop establishment

Certain crops require special attention during germination and seedling stage on the field, or because of pests and disease spread. Options for direct seeding and the planting of seedlings are the available options here. Certain crops are always sown, others, even in low input situations are always planted as seedlings. This can be dealt with appropriately in the spread sheet. Further data on seed properties have been included to estimate the price of sowing one hectare of the chosen crop.

2.6 Fertilization

Two options for manual and mechanical application of fertilizer have been included. Again, different crops may require specialized supply schemes that are represented by the inclusion of both fertilizer types as the physiological state in which the crop is present. Different times in the cycle may end in a different demand for nutrients compared to earlier or later stadia. In this comparative model, averages are used in order to generate comparable data.
Organic manure is taken as the sole fertilizer in case of the low input system. Use of organic manure is preferable in terms of sustainability but results in lower yields as compared to chemical fertilizer, this is included in the model.

2.7 Irrigation

To facilitate calculations for practical use, the construction costs of the complete irrigation system if present, are left out of the cost estimation. Since many variations exists between irrigation systems, the required price to pay by the farmer for use of this irrigation system has been dealt with by including these costs in the price of the irrigation water.

2.8 Weed control

Three options are given to represent different ways of weed control. We included complete manual weed control, which will generally be carried out with hand tools like a hoe or a spud. The costs are only represented in the labour costs. The second option of weed control is manual application of chemical herbicide while the third option is complete mechanized weed control using a tractor with a mechanical weeding device. Since certain crops (palms and trees) remain on the field for a prolonged time compared to annual crops, three sub options have been included to represent the different physiological cycles of a crop and its related required input. Annuals are only represented by data in the first sub option “establishment year”. In case of calculations the sub options “start of maturity” and “end of lifecycle” are to be filled in with a ‘1’ to cover this as explained in section 2.

2.9 Pruning

Pruning is included in the sheet as mechanical and manual pruning. Pruning is mainly done in the establishment phase of perennial crops (formation pruning) and in the end of the production cycle (maintenance pruning) in order to facilitate logistics of the harvest. Pruning is mainly carried out manually but in some cases mechanical pruning is applied in order to rejuvenate the plantation.

2.10 Pest and disease control

Here again a division is made between high and low input farming systems. It is assumed that no input on pest and disease control is used in the low input farming system. This assumption is based on the lower pressure of pest and diseases due to lower plant densities and better monitoring opportunities due to the smaller size than high input production systems. Nevertheless, the fact that no economic resources are spent on pest and disease control, will eventually result in lower yields. These considerations are included in the model.

2.11 Harvesting

For the parameter harvesting two options are possible: either mechanical harvesting (combine, specialized picking equipment) or manual harvesting (with simple tools). Depending on crop species different harvesting techniques are needed. Certain harvesting operations are mechanically (because of technical feasibility) difficult to achieve and are currently only done by hand. If so, for the mechanized option, an estimation has been made of the increased cost of a theoretical mechanical tool that would be able to handle the harvest.

3 RESULTS

If all data and parameters for crop growth in the specific location are filled in correctly, the results will be presented at the bottom of the spread sheet and at a separated sheet called 'comparison'. The results are expressed in several parameters like:

- Net Return [USD/ha/year],
- Return on Labour [USD/man-day],
- Total investment [USD/ha/year] and
- Different allocated cost of the production process

and can be used to compare the economic feasibility of the production of the included oil crops. For medium and high input production systems (APS 2 and APS 3) Net Return is an imported parameter in order to decide on the economic feasibility of production. For low input production system (APS 1) feasibility can be best expressed in Return on Labour (RoL) since the labour is put by the agricultural entrepreneur and does not represent a direct cost. The RoL expresses the amount of USD that the farmer earns per hour that (s)he spends on the agricultural activity.

The total investment is a good indicator in order to determine the need for capital. The overall feasibility is highly depending on the market price of the (oil) seeds. This again is related to the end use of the oil. In this model, prices are set for use for energy production.

As an example corn, jatropha and sunflower are compared for the different production systems. The net return and return on labour are expressed in USD.

	APS 1	*APS 2*	*APS 3*
corn			
net return	260	1055	235
USD/manday	6,34	63	179
jatropha			
net return	62	-169	-1396
USD/manday	2,46	-3	-648
sunflower			
net return	226	525	62
USD/manday	8,65	35	41

We observe the highest income for corn compared to jatropha and sunflower carried out for East African conditions. The net return is highest in APS 2 for corn and sunflower if compared to the other production systems. This is a result of high input resulting in high yield, but with use of own labour and low investments in equipment the costs are kept low. We also observe that the production of jatropha is only feasible in low input conditions, using own land and labour. Yields are not high enough to compensate the extra investments of high input. The return on labour is most promising for corn production in APS 3. This is because production of corn can be highly mechanized, so labour input is reduced to a minimum, while the net return is significant.

4 CONCLUSIONS AND RECOMMENDATIONS

This model is designed in order to compare several oil crops for their economic feasibility and can be used as a selection tool for different oil crops. Also beans and corn are included in this analysis in order to function as an anchor to which the other crops can be compared. Generally much information is available on these crops and can therefore be used as a fixed set point.

In general terms some conclusions can be drawn:

- In case of low labour costs, mechanized production activities tend to be more costly than the same activity carried out manually.
- Many plants have low oil yields and are therefore hardly economically feasible.
- The oil price is a major factor in the determination of the economic feasibility. If a significant market is available for food oil, this is reflected in the sales price of the oil seeds. If seeds will be used for biodiesel, a fixed price is used depending on quality of the oil but will be around half of the price as used for food oil.
- The parameter Return on Labour (RoL) is a good indicator to conclude on economic feasibility as compared to local minimum wage for other activities.
- The Return on Labour results in extremer values at the scenario of high input since labour requirement is relatively low and machine costs are high.
- Many agricultural activities on oil crops are not profitable with hired land and hired labour, but can be profitable with own land and own (family) labour.
- Highest investments are needed for high input agricultural management
- Highest labour is required in agricultural management with high input and family labour
- Palm oil is the most profitable crop for all agricultural systems
- When comparing annuals with perennial crops, we do not observe a significant relation with net return or RoL.
- When machine costs are reduced (by up scaling production area) high input systems can also reach net revenues.
- If more input is applied and own labour is used (APS 2), more net revenue or net losses are made if compared to low input production system (APS 1)
- The impact of labour costs and land costs is significant in APS 1 and 2
- Land costs are put to zero in the case of low input family systems

The results are not meant to be absolute numbers that will tell you how much the revenue of your agricultural activity will be, but mainly indicate the relation of feasibility between the oil crops in a specific region. The model is designed for the production of energy crops but would give a significant different picture if other applications would be included. Higher seed prices can be obtain when producing for cosmetics or pharmacy, but markets are more limited if compared to the energy market.

The use of by-products is not directly included in the model, but is expressed in the average market price of the different product of the crop. In the further development of this model, this different product streams will be separated in order to include more detailed product prices depending on the application of the by-products. This tool is suitable for other crops and can be included by the user. This will provide insight in the cost structure of the activity. Not only oil crops and food crops have to be included, but also crops for biomass production can be included in the analysis.