Introduction

Since 2007, ***agri benchmark*** Cash Crop has extended the analysis of typical arable farms into the details of production systems answering questions such as: What kind of operations are executed per crop? How often do they take place? What machinery is used? and of course, What is the total operating cost?

In this part of the report, corn production in the various countries is analyzed. Because in recent years the number of farms participating in the network has increased so much, a selection of farms is used.

As can be seen in Figure 2.1.1 the farms selected do not only represent major corn production regions but also a great variety of locations and farm sizes. In this figure the total cost of production per tonne is documented. Since especially in Europe we have to cope with inflated land prices, this calculation has been done excluding land cost – cash cost as well as opportunity cost for farmers' family owned land.

Economies of size?

Before looking at the details, the issue of economies of scale has to be addressed. In principle one would assume that – irrespective of the production system in place – with increasing farm size, operating cost per hectare and per tonne go down, because existing machinery and labor force are employed more efficiently than on small farms. However, as displayed in Figure 2.1.2 a significant impact of size on operating cost cannot be found in the whole sample of corn producing farms. There are several explanations for this result including: There are some large farms in the network, which represent former collective farms in Eastern Europe. These farms are typically characterized by a large number of workers employed. Even though wage rates are normally not that high, the pure size of the work force matters. In addition yield levels are rather modest for these farms (6 to 8 t/ha). This would be true for farms in the Ukraine, Czech Republic and Hungary.

Lean operations on small farms

There are also some relatively small farms in Argentina and the U.S. where operations have been outsourced to contractors. This – as will be demonstrated later on – turns out to be a rather competitive way of running operations in agriculture.

Lesson learned here is that in a global comparison, farm size alone does not explain a lot in terms of operating cost, hence it should be worthwhile to look at the details.

Focus group of farms

In Figure 2.1.1 five farms are marked in light red. The subsequent analysis will be focused on these farms. They have been chosen because they represent a gradient of total cost per tonne. Furthermore, they are located in key arable regions; Table 2.1.1 contains some important figures.

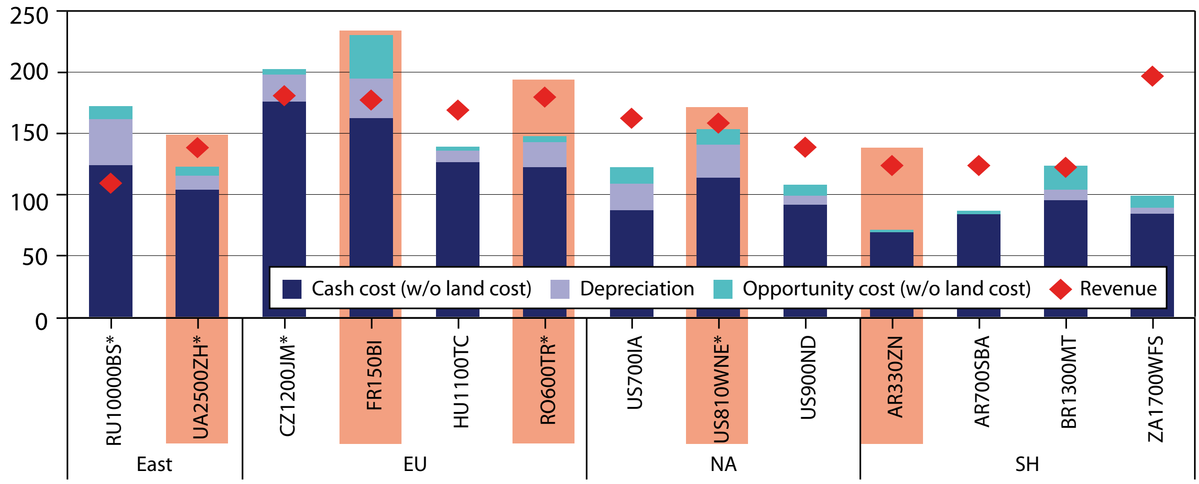
2.1.1: Key farm figures

	Yield t/ha	kg N/ha	Previous crop	Land cost USD/ha
UA2500	7.1	168	Wheat	51
FR150	11.1	160	Wheat	225
RO600	8.5	108	Sunflower	155
US810	11.3	216	Beans	330
AR330	9.5	86	Soybeans	310

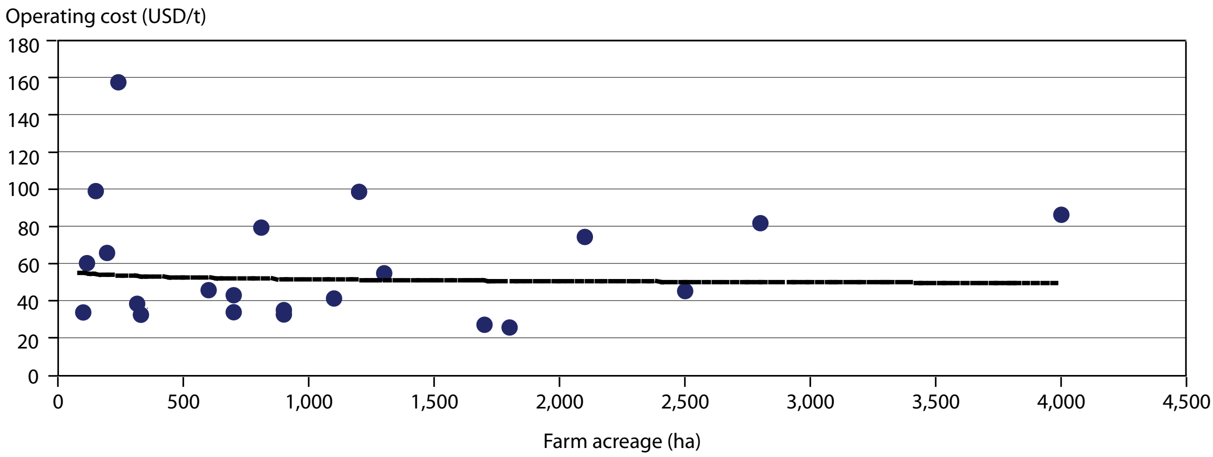
The most surprising figure is probably the high land cost in Argentina, which is almost the same level as in the U.S. On the other side, given direct payments of more than 400 USD/ha land cost for FR150 are extraordinary low. Reason for that is a special legal land regulation. Whether land rents of 225 USD/ha is the real land cost to the grower can be questioned.

Relative to the yield level, nitrogen input at UA2500 is high, while the French farm is rather productive in nitrogen usage. This is especially remarkable because there is no legume as a previous crop but wheat, which is also the case for the Ukrainian farm. The positive rotational effect of legumes as a previous crop can be seen in the Argentine farm and – to a lesser extent – in the U.S. farm.

2.1.1 Total cost and gross revenue in corn production – without land cost (USD/t)



2.1.2 Impact of farm size on operating cost in corn



Operating cost

As displayed in Figure 2.1.3 there are two distinct farm groups regarding operating cost per hectare: Farms with very high cost of 700 to 1,000 USD/ha located in France, U.S. and Czech Republic. The rest of the sample constitutes the second group, which exhibits operating cost of 300 to 400 USD/ha or less than half.

In Table 2.1.2 key values regarding labor cost are disclosed; the figures under "wage rate" are the weighted average of wage rates paid to hired labor force and hourly opportunity costs to family labor.

2.1.2: Key farm figures

	Wage rate USD/h	Total labor input h/ha	Share family labor input %
UA2500	1.9	53	0
FR150	21.0	20	66
RO600	3.7	16	30
US810	14.5	13	49
AR330	n.a.	n.a.	n.a.

Details for labor cost

Based on figures from Table 2.1.2 the following background information for individual farms is given:

- The French farm is the farm with highest labor cost (+400 USD/ha) associated with a labor input of 20 h/ha. Cost per hour averages at roughly 20 USD because yield is not that much higher relative to other farms in the sample. Also labor cost per tonne of corn is rather high. While at FR150 about 40 USD/t are spent for labor cost, the other farms spend less than half of that.
- The Ukrainian farm exhibits labor cost of about 100 USD/ha. Labor input is 53 h at an hourly rate of 1.9 USD. That means, even with extremely low wage rates, total labor cost don't have to be very low. Since yield is not that high, labor cost per tonne is 20 USD/t.
- Figures for RO600 demonstrate that more productive use of labor force helps to compensate for higher wage rates. Even though wage rate at this farm is about two times higher compared to UA2500, total labor cost of 59 USD/ha is only a little more than 50 % of that. This is because labor input is only 16 h which equals 30 % of what UA2500 uses. On a per-tonne-basis this farm spends less than 10 USD/t which makes the farm RO600 rather competitive in this sample.
- US810 is the farm with the lowest labor input (less than 13 h), but due to wage rates of 14.5 USD/h total labor cost is – together with the French and the Czech farm – the highest in the sample: 188 USD/ha. However, due to high yields, labor cost per tonne is only a little less than 20 USD/t.
- Due to the use of contractors nothing can be said about labor input and labor cost for AR330.

The bottom line regarding labor cost can be summarized as follows: In this sample, the most efficient labor input is realized by the farm RO600. Thanks to low wage rates and a high productivity, labor cost per tonne of corn are less than 10 USD.

The result for UA2500 suggests that there is a lot of overhead labor force which implies great potential for improvement. Even when reducing labor input by 50 % to 26 h/ha – which would still be more than twice of what farms in the U.S. or Romania realize – the farm could belong to the strongest in the sample.

Relatively unfavorable results for FR150 also reflect a lot of overhead cost in labor. Since 70 % of labor cost is opportunity cost the economic pressure caused by this disadvantage is less severe.

The strongest impact of high yields can be seen at US810: While spending almost 200 USD/ha, on a per-tonne-basis the farm is very cost efficient.

In the next chapter there will be a closer look at the details of the production system and whether this can shade some more light on total operating cost.

Machinery cost

Machinery cost per hectare – as displayed in Figure 2.1.3 – varies a lot in this sample. While the Ukrainian and the Romanian farms spend about 200 USD/ha for machinery the U.S. farming practice causes costs of 400 USD/ha and the French even 500 USD/ha.

Interestingly enough, the share of machinery in total operating cost is rather homogeneous: It is for all farms in this comparison by far the most important cost component, which makes up between 40 and 50 % of operating cost (see Figure 2.1.5).

Impact of production systems

To what degree these differences in machinery cost are caused by differences in operations will be analyzed now. Figure 2.1.6 demonstrates what kind of operations usually take place on the various farms.

Regarding UA2500 the following features are important:

- There are four tillage passes but only one herbicide application.
- The farm heavily relies on organic fertilizers, which is causing some higher labor input.

When looking at the figure of the French production system, the following issues pop up:

- The tillage system is pretty straight forward: two passes in the autumn and one at seeding.
- What makes this system expensive in terms of labor and machinery input is intensive irrigation and the relatively small size of the farm.
- Fertilizers are applied separately which of course increases machine run times and the use of machinery.

Production system of US810 can be described with these bullet points:

- One of the most intensive systems in the comparison: nine times irrigation, three times herbicide application and two times fertilizer – but no tillage. Because of dry beans being the previous crop the farm is able to practice direct seeding.
- Machinery cost for the center pivot irrigation is about 70 USD/ha.
- From these figures it can be concluded that the low total labor input must be caused by highly productive machinery, which in turn explains high machinery cost – plus investments in center pivots of course.

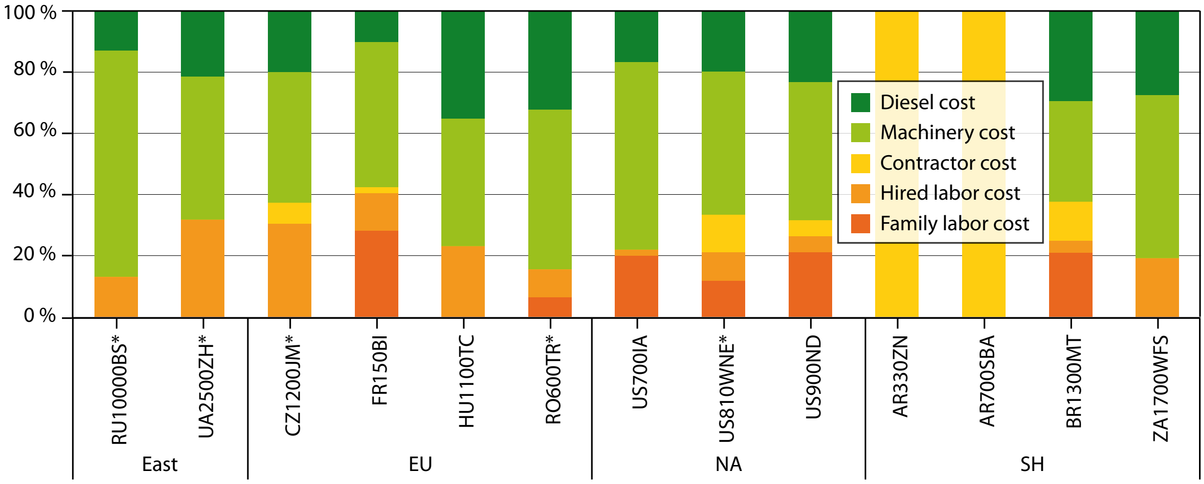
Regarding field operations at the farm RO600 (see Figure 2.1.6) there are some similarities with UA2500: Three tillage passes, two fertilizer applications and one herbicide pass – that's it.

The production system at AR330 is the simplest and the cheapest in the sample: Direct seeding, two fertilizer applications and one plant protection pass. Total cost for operations is about 300 USD/ha, on a per-tonne-basis the farm uses only roughly 30 USD/t.

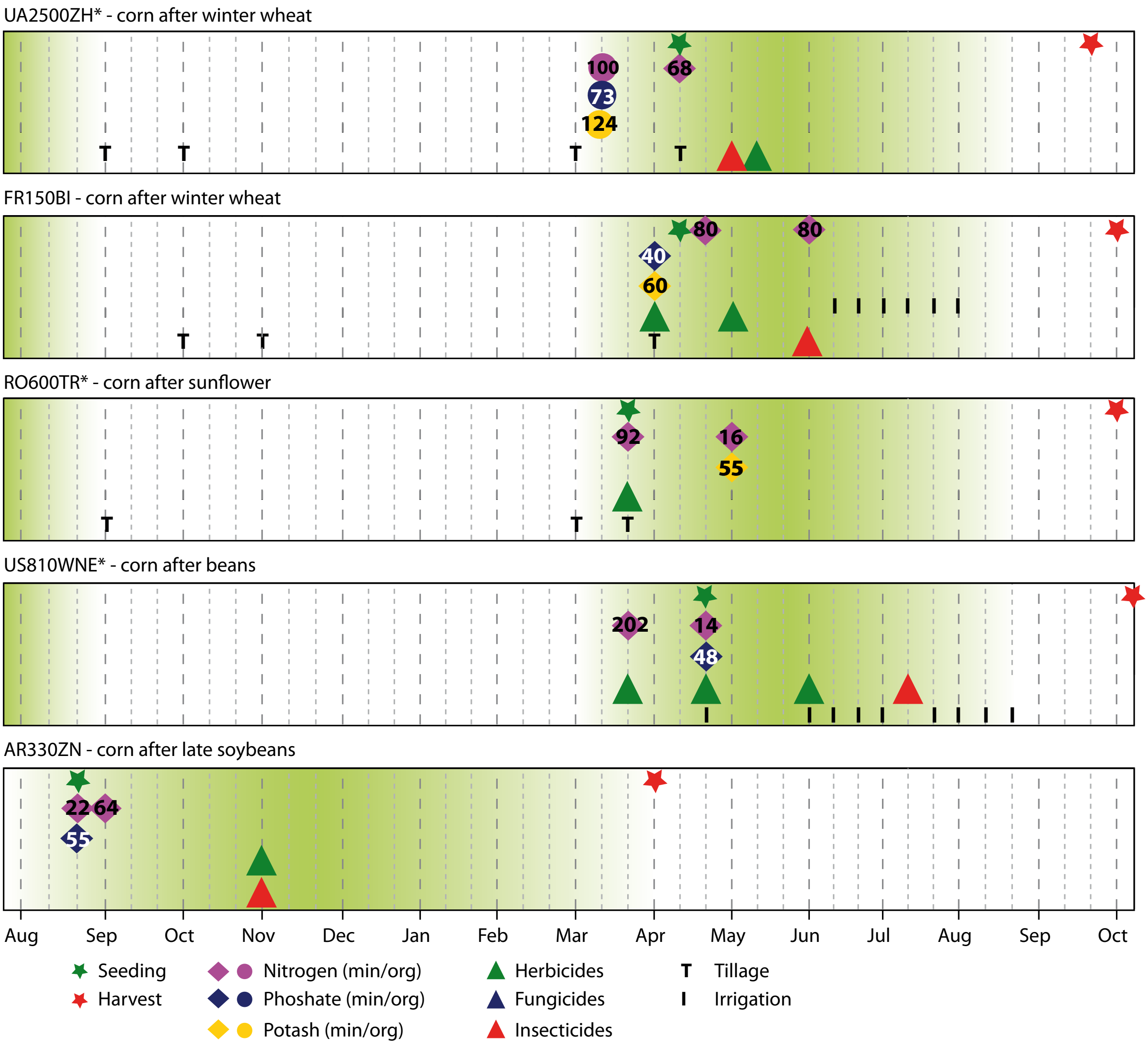
Bottom line:

- There are some significant differences in production systems applied – the most remarkable with major economic implications is irrigation. Since the irrigation technology is treated as a machine, irrigated farms do not only use more labor but also cause more machinery cost.
- The very high labor input at UA2500 can only partially be explained by the production system. Low machinery cost is caused by the fact that this farm to a certain extent uses Eastern technology, which tends to be less expensive. Plus, the size of the farm allows them to make use of economies of scale.
- High labor input for FR150 is partially caused by the irrigation system employed. However, with a larger operation it should be possible to improve productive usage of labor force.
- Operating cost for US810 is almost two times higher than for AR330 but yield is only 20 % higher. This is the most important reason for relatively weak stand of the U.S. farm.
- Provided the significant differences in received crop prices are lasting, differences in cost of production are economically rational and will persist.

2.1.5 Cost structure of operating cost (%)



2.1.6 Production systems in corn – UA2500, FR150, RO600, US810, AR330



2.3 Economics of palm oil vs. soybeans and rapeseed

Introduction

With increasing global demand for vegetable oils for both food and biofuels, the question arises what raw materials are the most competitive ones from an economic standpoint. This does not only include current cost of production but also strategic positioning of raw materials especially with regard to most likely increasing energy and labor cost. Furthermore, with regard to global warming and greenhouse gas emissions, the productivity of nitrogen usage in the various crops is of upmost importance.

The following comparison includes soybeans, rapeseed and oil palm, which globally belong to the most important oil crops. In the Cash Crop Report 2008 there was a detailed description of the production system in palm oil.

This comparison has to cope with the fact that the mentioned crops contain two distinct and high value components: oil and protein. Hence, analysis starts with the presentation of a methodology how to allocate cost to the different outputs.

Concept

The aim is to identify cost of the agricultural raw material production per tonne of vegetable oil. This will be achieved by the following steps:

1. Calculating the vegetable oil production per hectare, based on the oil content of the agricultural raw products. In soybeans 18 % of the commodity is assumed to be the average oil content, in rapeseed 42 % and in palm oil 22 %.
2. The next step is to allocate the cost of agricultural production to the vegetable oil output from the oil crops. Here, value shares of the final outputs "vegetable oil" and "protein meal" have been used. A respective analysis of statistical data reveals that about 80 % of the total value of rapeseed, 40 % of soybeans and 90 % of palm oil stems from the oil content of the crops.
3. When calculating the importance of nitrogen and labor input, the same approach has been used to allocate respective cost and quantities per tonne of vegetable oil.

Vegetable oil yield per hectare

The analysis of cost of production starts with calculating the oil yield per hectare. In Figure 2.3.1 the respective values can be seen. The following findings are worth mentioning:

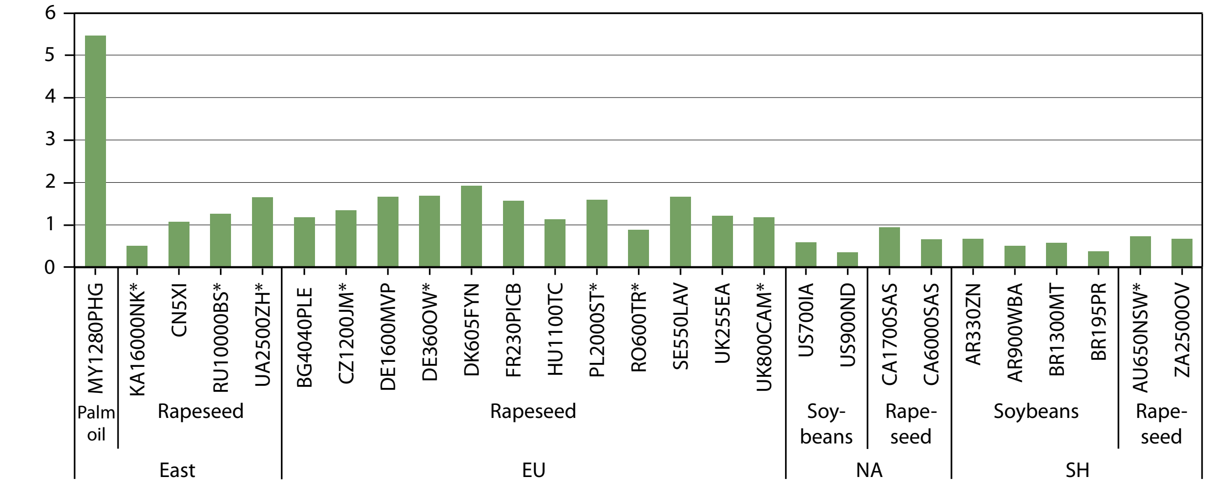
- Palm oil produced at the typical plantation MY1280 has a very strong stand in this comparison: 5.5 t/ha vegetable oil output compares to 0.5 t/ha in soybeans or 2 t/ha at most in rapeseed.
- On average, typical European ***agri benchmark*** farms are much more productive in rapeseed production than their Australian, Canadian or Asian counterparts. While in Europe, many farms produce about 1.5 t/ha, in Australia or Kazakhstan the respective values are in the range of 0.5 t/ha.
- In global soybean production the oil yield per hectare is much lower but also much more homogeneous. The yields vary between 0.4 and 0.7 t/ha.

Cost per tonne of vegetable oil

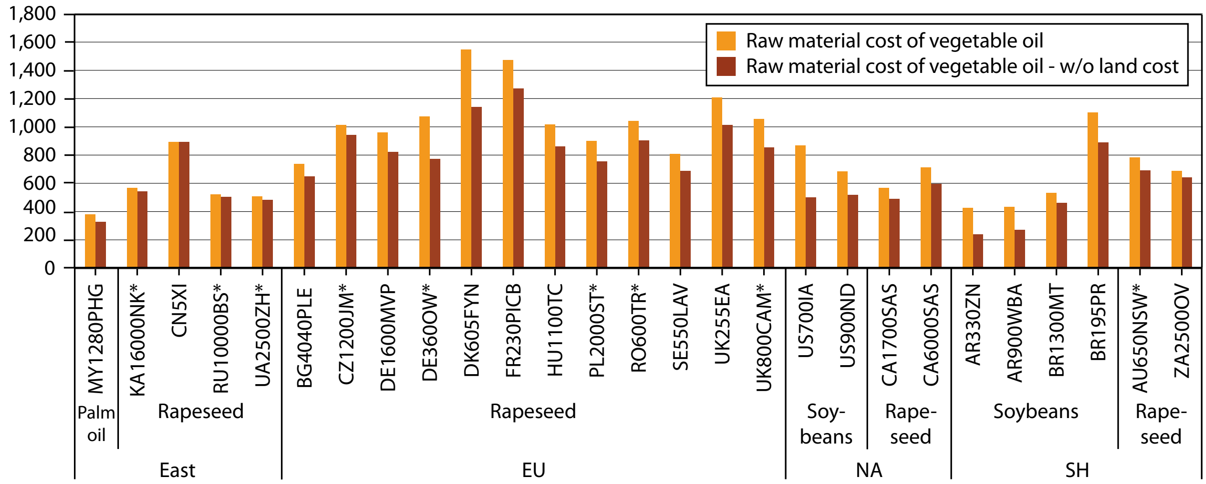
Based on the cost allocation concept defined above, raw material costs per tonne of oil have been calculated; Figure 2.3.2 displays the results. Key findings including land cost (see orange bars) are:

- With production cost of 380 USD/t palm oil – together with soybean based oil production of typical farms in Argentina and on the large Brazilian farm – is by far the cheapest way to produce oil.
- Very low cost of Argentine farms are necessary due to low prices which are caused by export taxes on soy products of about 30 to 35 % – depending on the degree of processing. Depressed prices lead to a rather low intensity of input usage. Given the high land prices in Argentina in a liberalized environment there would be a strong economic incentive to intensify production.
- Cost for BR1300 has to be low also, because this farm is located in the remote State Matto Grosso which causes high domestic transport cost of about 50 USD/t in order to reach export and processing facilities and low farm gate prices. The other Brazilian farm is in Parana which is much closer to the harbor. Consequently, farm gate prices are much higher.

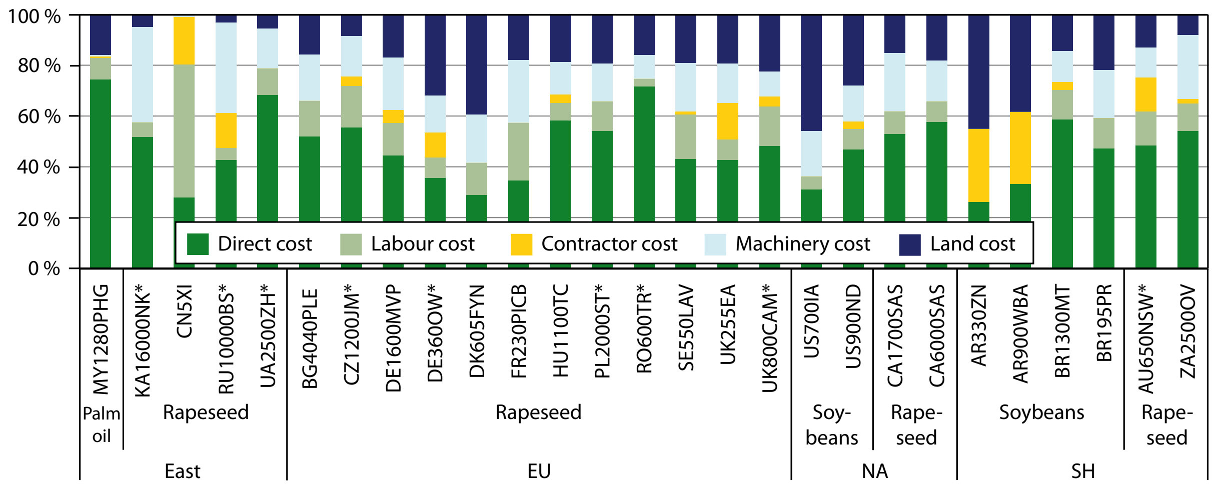
2.3.1 Vegetable oil production – raw material (t/ha)



2.3.2 Cost of raw material production for vegetable oil (USD/t)



2.3.3 Cost structure raw material production vegetable oil (%)



- The second most cost effective group of typical farms is based in the former Soviet Union, namely in Russia, Kazakhstan and Ukraine; the cost figure for this group is about 500 USD/t. Also for this group of farms domestic transport cost matter a lot.
- The third group consists of other not yet mentioned soybean producers as well as Canadian and Australian growers. They have to spend about 600 to 800 USD/t in order to produce raw material for one tonne of vegetable oil.
- Finally, the majority of European ***agri benchmark*** rapeseed producers are spending about 1,000 to 1,200 USD/t and even more in order to produce raw material for one tonne of vegetable oil.

The impact of inflated land cost

Figure 2.3.2 also contains a category called "raw material cost without land cost" (red bars). The reason for this is, that especially in the EU, – depending on the region – farmers receive decoupled government payments between 150 and 400 USD/ha. Since these payments, in the end, result in higher land rents, cost of production in Europe are inflated. In order to get an understanding about the "real" cost of production, respective values have been calculated. The key messages from this exercise are:

- In general, the gap between high costs in Europe and the rest of the world narrows. For instance, cost of production for farms in France, Sweden, Denmark or Germany is reduced by 200 to almost 400 USD/t or by 20 to 40 %. The resulting cost of production are in the range of 800 USD/t which is the same level as the small Brazilian farm or the one in South Africa.
- However, even without land cost, the ranking of crops and regions is not reversed.
- Palm oil production at MY1280 does not dependent that much on land cost, but still on a per-tonne basis the reduction is 50 USD/t or about 15 %.

Different cost structures

In order to get a better understanding about key cost factors at the different locations, Figure 2.3.3 contains a break down in relative terms.

Most remarkable is the fact that palm oil production at the typical plantation MY1280PHG is primarily driven by direct cost such as fertilizers and plant protection cost. Land cost only accounts for roughly 15 %. At the other end of the spectrum there are South American farms in Argentina on which only about 30 % of all costs are spent on direct cost. These two farms – together with the UK255 and CN5XI – very much rely on contractor input. Their share of spending for contractors is in the range of 20 to 30 %.

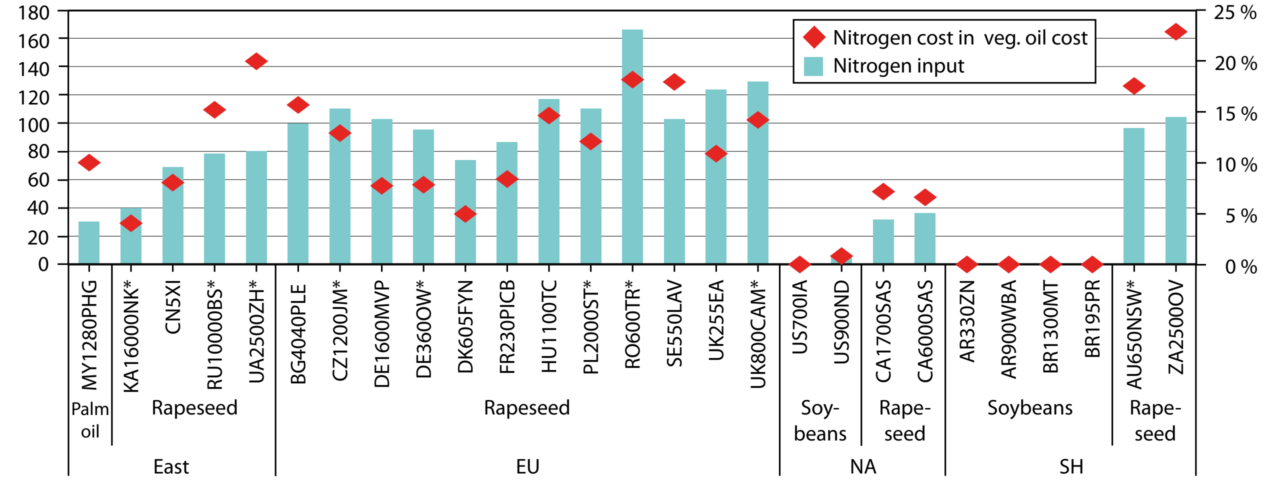
Impact of nitrogen fertilization

As demonstrated in Figure 2.3.4, the intensity of nitrogen application differs dramatically between different crops. The following findings are most important:

- Because soybeans are a leguminous crop, there is no relevant nitrogen input and consequently, the share in total cost is negligible or even zero.
- In terms of cost for nitrogen input per tonne of raw product, palm oil is the next best crop – only 30 kg are needed. However, due to very high nitrogen prices in 2008 and very low total cost the share of nitrogen cost for MY1280 is relatively high (approximately 10 %).
- The only oil production systems which are at the same level as palm oil are ***agri benchmark*** farms in Canada and Kazakhstan, which produce rapeseed.
- In general, rapeseed based oil production is very nitrogen intensive: about 100 kg/t are needed. The share of nitrogen cost in total cost fluctuates between nearly 10 % and up to 20 %.
- With regard to the productivity of nitrogen input, the results for the two German and the Danish farms are worth to note, because these three farms have the highest oil production per hectare among all rapeseed producing farms (see Figure 2.3.1) but nitrogen input per tonne of vegetable oil is the lowest among EU farms.

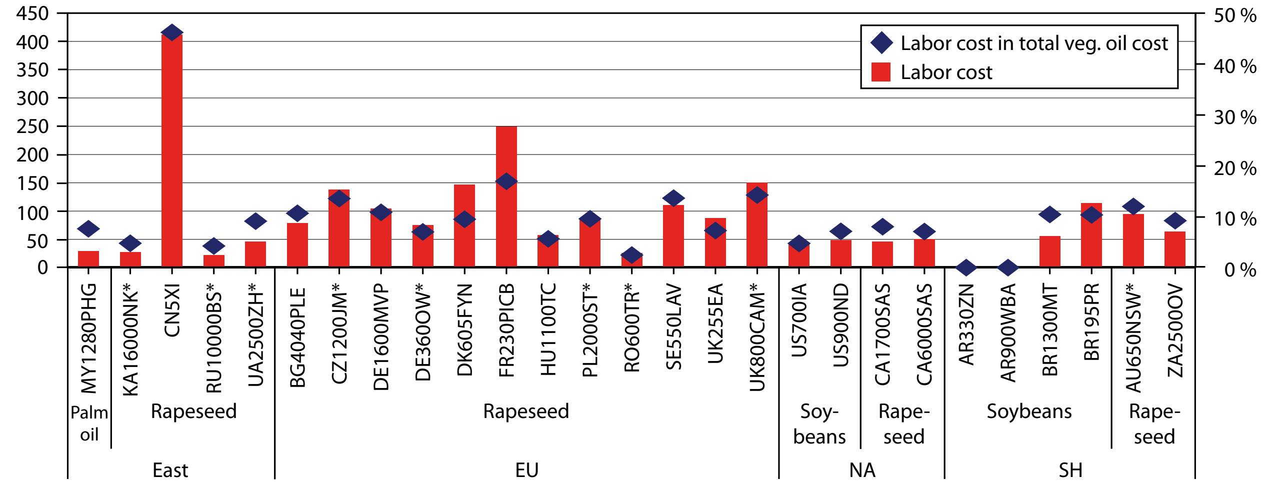
2.3.4 Specific nitrogen input for raw material production for vegetable oil

(left y-axis: kg N/t veg. oil; right y-axis: %)



2.3.5 Specific labor input for raw material production for vegetable oil

(left y-axis: USD/t veg. oil; right y-axis: %)



Palm oil production in Malaysia

From these findings it can be concluded that palm oil is not as competitive as soybeans in terms of dependency on nitrogen input but much better than most locations and production systems for rapeseed production.

Impact of labor cost

Since palm oil production – or to be more precise – harvest of fresh fruit bunches is very labor intensive, the question arises, to what degree palm oil production is vulnerable with regard to increasing labor cost. Therefore a calculation of labor cost per tonne of raw material has been done. Furthermore the share of labor cost in total cost was calculated (see Figure 2.3.5).

Regarding the importance of labor cost, the following results are worthwhile to mention:

- Except for outliers in China and France, labor cost fluctuate between 25 USD and 150 USD. Zero values for the Argentine farms are due to the fact that they totally rely on contract work. Since contractor cost include labor cost, machinery and diesel cost it is impossible to identify the labor cost share in it. Because contract work is very important for UK255EA labor cost value for this farm has to be treated with some caution.
- The share of labor cost in total cost can be as low as less than 5 % in the Romanian farm and almost roughly 20 % for the French, the Swedish, the Czech or the larger UK farm.
- The extreme high value for the Chinese farm is caused by the extreme high labor input: every single plant is pre-grown in a nursery and transplanted by hand. On a per hectare basis, labor input would be more than 1,000 h. Due to low opportunity cost for family labor input (0.5 USD/h) labor cost per hectare is still reasonable but very high.
- Surprisingly, due to very low labor cost per hour (1.4 USD/h) labor cost for the palm oil production is very low (25 USD/t) and even the share in total cost is only about 7.5 %. This is slightly higher than what is realized by the farms in Kazakhstan, Russia and Romania but still very competitive in the rest of the sample.

Conclusions

- To the extent crop specific consumer preferences do occur in the market place, market prices for different vegetable oils may differ permanently and hence cost of production alone do no longer drive the decision making in the market.
- This comparison is limited to the cost of production at farm level. In case crops compared cause different costs in processing, this will affect the competitive position of the crops. The future expansion of ***agri benchmark*** analysis into processing will generate new insights.
- Costs of raw material production per tonne of rapeseed oil is in the range of 1,000 to 1,200 USD/t as far as Western Europe is concerned; typical farms in Eastern Europe and Australia have to spend roughly 500 to 700 USD/t. In soybeans respective costs vary between 400 USD/t in Argentina and Brazil and 800 USD/t in the U.S. Compared to the results in palm oil, where the typical plantation exhibits cost of production of about 380 USD/t, the majority of other crops and production systems are rather expensive.
- This strong economic position of palm oil is not only valid under current framework conditions but also in a high world crude oil price, which we most likely will experience in the foreseeable future. The main reason for this is the high nitrogen productivity of palm oil. While in rapeseed one tonne of vegetable oil requires about 100 kg of nitrogen, in palm oil the respective figure is only about 25 kg/t or 25 %. With regard to GHG-balances, this result puts palm oil production into relatively strong positive position. The nitrogen cost per tonne of raw material for vegetable oil is about 30 USD/t in palm oil but about 100 USD/t in rapeseed.
- The typical oil palm plantation uses more than 120 hours per hectare and year, the typical arable production for soybeans or rapeseed only involves less than a 10th of that. But since wage rates are currently very low in countries like Malaysia, labor cost per tonne of raw material is just about 25 USD/t while major soybean and rapeseed producers have to spend about 50 to 100 USD/t and more.