# Economic viability of cowpea (Vigna unguiculata) in the Cerrado region

https://doi.org/10.56238/levv15n39-099

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## ABSTRACT

The cowpea crop has a high protein content and is a pulse crop, with greater consumption in countries of the African continent and Asia. It is cultivated in arid and semi-arid regions. It is a crop that is cultivated both rainfed and irrigated, with different technological levels in Brazil. The study with the economic viability of this crop in the Cerrado region is important to facilitate the management of rural producers. Thus, the objective of this study was to economically evaluate rainfed cowpea in the second crop in a cerrado region, in succession to soybean. The study was conducted in the field, on a farm located in the municipality of Rio Verde, southwest region of the state of Goiás, being conducted for three harvests (2015/2016, 2016/2017 and 2017/2018) with soybean alternation in the first harvest, all via no-tillage. The economic result in the three harvests proved to be viable only in the first harvest (2015/2016) and unfeasible in the others, due to low productivity, seasonality of market prices and high production cost. The low productivity and the commercialization price were low compared to the costs and efforts applied compared to the opportunity cost of other crops. The economic viability of cowpea is directly related to the price paid for the bean, which results in great price variability. As well as, the study of cowpea cultivars more adapted to the region.

**Keywords:** Production Costs, Economic Analysis, Financial Return, Cowpea.

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## INTRODUCTION

Cowpea (*Vigna unguiculata L. Walp*.), also known as cowpea, branch beans, beach beans, road beans, black-eyed peas or macassar. It has its origin in the African continent, was introduced in Brazil in the seventeenth century, belongs to the Fabaceae family, and is currently widely cultivated and consumed in the North and Northeast regions of Brazil (SILVA; OLIVEIRA, 1993; OLIVEIRA JÚNIOR *et al*., 2000; VIEIRA *et al.*, 2000)

Cowpea is a rich source of vegetable protein, important in the Brazilian arid to semi-arid region, especially for the Northeast region, but with an expansive presence in the northern region. In this context, cowpea becomes an ally for subsistence peasant agriculture in the region due to its characteristics of rusticity, good tolerance to water stress and precocity. Its cultivation is also carried out in irrigated areas with a high technological level, for better optimization of the productive, economic and social potential of this crop (OLIVEIRA *et al*., 2009).

The expansion of cowpea cultivation in cerrado areas may be related to the increase in international demand for this grain. This is due to the inclusion of cowpea in the group of *pulses*, a European classification that refers to dried oilseeds with low oil content, including peas, lentils, chickpeas. The European market is a major consumer of *pulses*, so some producers have already started exporting and evidenced the good economic business, continuing the cultivation and its expansion (CASTRO JUNIOR, 2015).

Cowpea, like common beans, can be grown in three seasons (CONAB, 2019). In the Northeast region, the first harvest was 362.4 thousand hectares, with an increase of 6% compared to the previous harvest 2017/2018, with average productivity between 300 and 440 kg $^{ha-1}$. The state of Mato Grosso cultivates in the second harvest, as an off-season option with an approximate average productivity of 1,105 kg $^{ha-1}$, the highest productivity is related to the high technological level of the region. In the state of Minas Gerais, the cultivated area was 16.5 thousand hectares, an area 19.6% larger than the previous 2017/2018 harvest, with an average productivity of 545 kg $^{ha-1}$, and most of this cultivation is concentrated in the northern region of the state due to edaphoclimatic conditions. In the third harvest, the states of Tocantins and Bahia stand out, with their respective cultivated areas in the 2018/2019 harvest of 11 thousand and 10 thousand hectares with an average productivity of 1,536 kg $^{ha-1}$ and 417 kg $^{ha-1}$, respectively (CONAB, 2019).

In order for the producer to make a profit in the cultivation of beans, it is necessary that the cultivation goes through some stages such as planning, management of the area, sowing, cultural treatments and harvesting (RICHETI and MELO, 2012). Planning is then a fundamental part of the administrative management of the property, regardless of the technological level chosen. In the irrigated cowpea cultivation in the State of Piauí, Mousinho et al. (2008) obtained yields above US$

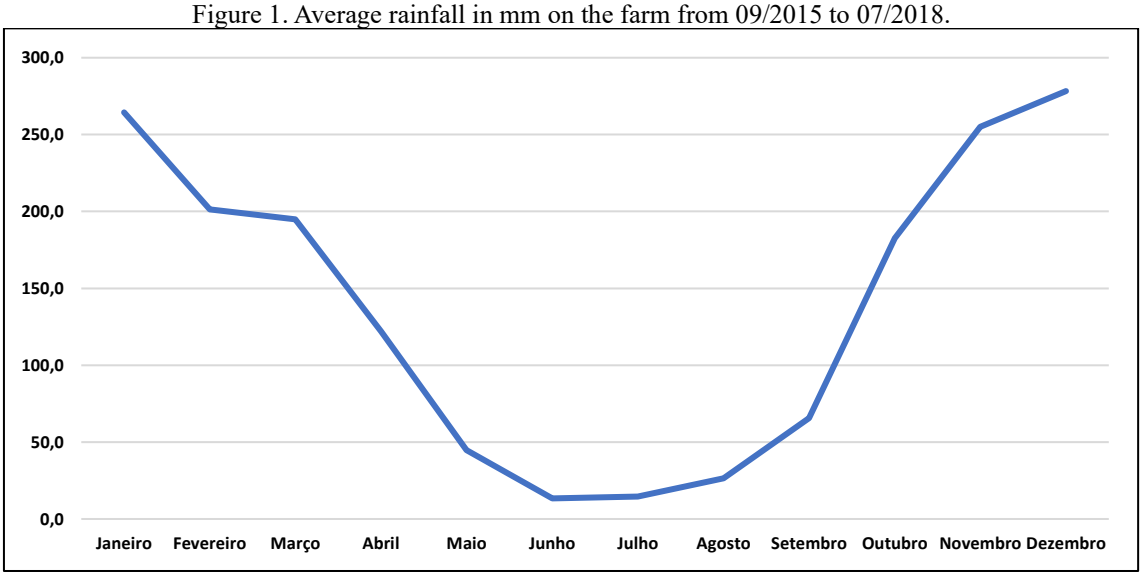
450.00 $^{ha-1}$, indicating that its cultivation is economically viable. Irrigated planting in the State of Rio Grande do Norte is higher than when cowpea is conducted in rainfed conditions, with a net income of R$ 10,586.26 (SILVA et al., 2016). Castro Júnior (2015) highlighted the positive effects of the economic analysis of cowpea and identified greater profitability when the crop was irrigated in Maranhão.

In this sense, the objective of this study was to economically evaluate three cowpea crops in the cerrado region, cultivated in the second harvest, in the municipality of Rio Verde - GO, in succession with soybean.

## MATERIAL AND METHODS

The experiment was conducted for three years in the 2015/2016, 2016/2017 and 2017/2018 seasons. On the farm located in the municipality of Rio Verde, in the southwestern region of the state of Goiás, whose geographic coordinates are S 17°36'00" and W 51°20'33", altitude of 760 meters and rainy subtropical climate, with dry winter, type Cfa, according to the Köeppen criterion. The average rainfall was evaluated in the years 2015 to 2018, according to the meteorological station on the farm in Rio Verde - GO (Figure 1).

Figure 1. Average rainfall in mm on the farm from 09/2015 to 07/2018.




Source: Authors, 2019.

The farm has a static agricultural area of 3,500 hectares, and it is possible to carry out two dry harvests in this area, with soybeans predominating in its entirety in the first harvest, which begins in October of each year. The second crop crops (off-season), in this case, cowpea started following the end of the soybean harvest between the months of February and March of each year.

In the three harvests, the planting technique used was no-tillage, with a spacing of 50 centimeters between rows, with an initial stand of 220,000 plants per hectare, using 13 seeds per linear meter of planting, using the Nova Era variety in the three harvests.

The cultivated area for each cycle was 91.14 hectares in the 2015/2016 harvest, 133.30 hectares in the 2016/2017 harvest and 543.30 hectares in the 2017/2018 harvest. These areas were cultivated according to the planning of the first harvest, taking into account the planting dates and climatic conditions for the period of the second harvest, which comprises between February and July of the aforementioned production cycle.

Planting in all years was carried out without base fertilization, due to the residual left by the soybean crop. The planting dates of the three crops are between 02/22 and 03/16 of each cycle. The harvest was mechanized, and its commercialization was carried out in several sales lots, in order to obtain a better average marketing price at the end of each cycle. In all harvests, the management was similar, with one application of selective herbicide to control tiguera soybean, two applications of insecticides from flowering and one of fungicide for DFCs (end-of-cycle diseases) in the post-planting period.

The data and information of the production process were recorded in all phases of the crop cycle by the operators and passed on to the office, which in turn imputed them in a rural management software used by the property. Thus, it was possible to collect information regarding direct and indirect costs for the composition of the total cost and analyses, as well as the average sale price of each production cycle in order to determine the economic and financial result of each harvest.

The production costs followed an adaptation of the CONAB methodology (2018), in order to better adapt to the managerial control by the farm. The variables adopted were: Fertilizers, Pesticides, Maintenance of Machinery/Implements, Depreciation, Opportunity Cost (land), remuneration of the

working capital and administrative expenses (which includes interest, social charges, transportation, technical assistance, insurance, fixed and temporary labor, rents) a synthetic way of aggregating several expenses considered managerial in a single operation, and does not hear an operation with an airplane.

To evaluate the gross revenue, the average selling price per 60 kg bag was used, from several contracts closed at different times and conditions. In some cases in short or long intervals, making a need to search for better price opportunities, since, at times, the producer makes sales due to the need to generate cash. And at other times of the need to ensure a good marketing margin in front of the break-even point calculated by the producer, with the defined price, where it is multiplied by the productivity (SC $^{ha-1}$) resulting in the gross revenue $^{ha-1}$, which when subtracting the cost of this, results in the net revenue $^{ha-1}$.

For the elaboration of the tables and figures, the R software was used, and Microsoft Excel, using the statistical tools, it was possible to corroborate and contribute to the discussion about the results achieved.

## RESULTS AND DISCUSSION

The average yield varied in the three harvests (Table 1), probably due to the climatic conditions, since in the second harvest of each year, the reserve rainfall indices are irregular and present uneven distribution (Figure 1). Higher productivity was found in the 2015/2016 harvest with 1,657.80 kg $^{ha-1}$, followed by the 2017/2018 harvest with 1,332.00 kg $^{ha-1}$ and with the lowest productivity in the 2016/2017 harvest with 1,059.00 kg $^{ha-1}$ (Table 1). The productivity of the 2016/2017 harvest reduced 36.12% due to the 2015/2016 harvest and 20.50% compared to the last harvest analyzed 2017/2018. However, the yield of the three harvests was high or similar when compared to other authors such as Silva et al. (2016) and Mousinho (2008).

Table 1. Productivity, average price paid per bag (PMP), gross revenue, seeds, pesticides, machinery maintenance, depreciation, administrative expenses, opportunity cost, working capital remuneration and total cost of three agricultural harvests 2015/2016, 2016/2017 and 2017/2018 in Cristalina – GO.

| Crops | Prod (kg $^{ha-1}$) | PMP (60 kg) | Gross income | Seed | Defensive | Machine Maintenance | Depreciation | Desp. Adm | Oppor t. cost | Rem. from Capital Circ | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015/2016 | 1.657,80 | R$ 130,00 | R$ 3.591,90 | R$ 90,00 | R$ 760,02 | R$ 182,29 | R$ 124,25 | R$ 624,57 | R$ 410,35 | R$ 94,01 | R$ 2.285,49 |
| 2016/2017 | 1.059,00 | R$ 60,00 | R$ 1.059,00 | R$ 98,00 | R$ 696,82 | R$ 263,30 | R$ 126,32 | R$ 781,35 | R$ 419,10 | R$ 104,49 | R$ 2.489,38 |
| 2017/2018 | 1.332,00 | R$ 43,75 | R$ 971,25 | R$ 110,00 | R$ 401,37 | R$ 185,15 | R$ 123,71 | R$ 803,25 | R$ 500,31 | R$ 83,39 | R$ 2.207,18 |

Source: Authors, 2019.

Total costs were higher in the 2016/2017 harvest, in the second agricultural year, in this harvest the administrative and defensive expenses component impacted costs (Table 1). The 2015/2016 harvest also had a greater impact on the crop protection component (Table 1). The higher cost of pesticides, as well as the oscillation with each agricultural harvest, is due to the agricultural year and climate of the region at the time, which can favor the growth of populations of insects and other diseases, so there is greater expenditure on pesticides to protect the plants. The 2017/2018 harvest had the lowest production cost and the administrative expenses component had the highest weight in the final cost (Table 1). For the three agricultural seasons, the costs were higher when compared to Silva et al.

(2016), in the Northeast, with production costs ranging from R$1,513.17 and R$1,275.67, for irrigated and rainfed cowpea crops, respectively. Probably the lowest cost is related to the technological level adopted by the authors, as well as to the price of inputs in the agricultural year in question.

Average productivity per hectare is an important factor for increasing crop profitability (KAMOI, MYT et al. 2019). In this sense, the gross revenue (Table 1) followed the cowpea yield of each harvest. In other words, the crops with the highest grain yield per hectare also obtained higher gross revenue. The highest revenues followed from the 2015/2016, 2016/2017 and 2017/2018 harvests (Table 1). The last harvest may have obtained lower gross revenue due to the lower average price paid for the bag of beans at the time, since its productivity was higher than the second agricultural year evaluated (2016/2017).

Obtaining the best possible price in the sales of agricultural products is important, especially for cowpea and common bean grains. This is due to its great market volatility, which causes a different dynamic in price formation, mainly because it is a product for the domestic market in almost its entirety productive (MOUSINHO, 2008). Therefore, production costs must be low and the maximum grain yield sought in each crop so that it is possible to obtain greater profitability.

The cost of inputs ranged from R$ 401.40 to R$ 160.50, with a mean of R$ 619.40 and a standard deviation of R$ 191.45 (Table 2). Regarding fertilizers, it was found that in 25% of the harvests the costs with fertilizers were above R$ 860.20 (1st Q) with a maximum of R$ 1,215.30 (Table 2). For pesticides, producers invested, on average, R$ 659.60, with a variation of R$ 502.50 to R$ 730.70. The average maintenance/machine was R$ 152.40 with a standard deviation of R$ 16.70 (Table 2).

Table 2. Descriptive analysis of the quantitative variables analyzed from three cowpea harvests in Cristalina - GO.

| Variables | My. | 1st Q | With. | Average | 3rd Q | Max. | DP | CV% |
|---|---|---|---|---|---|---|---|---|
| Area | 117,00 | 125,20 | 133,30 | 264,50 | 338,30 | 543,30 | 241,56 | 91,31 |
| Inputs | 401,40 | 549,10 | 696,80 | 619,40 | 728,40 | 160,0 | 191,45 | 30,91 |
| Maintenance / Máq. | 182,30 | 183,70 | 185,20 | 210,20 | 224,20 | 263,30 | 45,97 | 21,83 |
| Depreciation | 123,70 | 124,00 | 124,20 | 124,20 | 124,80 | 125,30 | 125,30 | 126,30 |
| Desp. Adm | 624,60 | 703,00 | 781,40 | 736,40 | 792,30 | 803,20 | 97,46 | 13,23 |
| Cost oport. | 410,40 | 414,70 | 419,10 | 443,30 | 459,70 | 500,30 | 49,61 | 11,19 |
| Rem. Capital | 83,39 | 88,70 | 94,01 | 93,96 | 99,25 | 104,49 | 10,55 | 11,23 |
| Productivity | 17,65 | 19,93 | 22,20 | 22,49 | 24,91 | 27,63 | 4,99 | 22,21 |
| Average selling price | 43,75 | 51,88 | 60,00 | 77,92 | 95,00 | 130,00 | 45,83 | 58,82 |

Source: Authors, 2019.

Note: Min. = minimum; 1st Q = 1st quartile; Mean = median; 3rd Q = 3rd quartile; Max. = maximum; SD = standard deviation; CV = coefficient of variation.

For the cost of depreciation, 50% of the agricultural crops had a cost below R$ 130.70, a value very close to the average, R$ 129.30 (Table 2). Administrative expenses ranged from R$ 285.50 to R$ 508.20. The opportunity cost presented an average of R$ 413.70 with a standard deviation of R$ 15.50. For the return on capital, it was found that 75% of the harvests had a cost below R$ 183.90 (3ºQ).

Productivity ranged from R$ 46.59 to R$ 72.62, with a mean of R$ 64.74 and a standard deviation of R$ 10.50 (Table 2). The average sales price varied from R$ 59.60 to R$ 70.33, with the average and median values very close to R$ 65.05 and R$ 65.30, respectively.

Regarding the coefficient of variation, a measure of relative dispersion, it was observed that the opportunity cost was the most homogeneous among all the variables, considering the harvests analyzed (CV = 3.75%), followed by the average sales price (CV = 7.98%). On the other hand, the cost of seed was the one that presented the greatest variation (CV = 29.06%), in relation to the other variables studied.

The profitability of the crops was different according to the agricultural season (Table 1). The only positive profitability was the 2015/2016 harvest (Table 1). The 2016/2017 and 2017/2018 harvests showed negative profitability, i.e., a loss above R$ 1,000.00 (Table 1). These results indicate that both grain production and the price paid for the product directly impact the rural producer's net revenue. One option is to reduce production costs in order to achieve sufficient net revenue to generate profit for those who produce. This result indicates that cowpea crops in cerrado areas need to be more productive and it is necessary to obtain better market prices, in addition to the low cost of production. All these factors are only possible when aligned, so it is important to use cultivars suitable for the region and plan the entire crop from the purchase of seeds to harvesting and storing the grains.

In order to make a profit in the 2016/2017 harvest, it would be necessary to sell a bag of cowpea for R$ 141.04 and/or produce 41.49 SC $^{ha-1}$. In the 2017/2018 harvest, the sale value should be R$ 99.42 and/or produce 50.45 SC $^{ha-1}$ so that it would be possible to reach the zero point of loss/profit, and above that, obtain minimally satisfactory economic results.

Regarding the correlation between the cost and economic variables, it was found that gross revenue showed a strong positive association with input costs, depreciation and average price paid for the bag, this indicates that with the increase in input prices there is consequently an increase in gross revenue, as well as the price paid for the bag that proportionally impacts gross revenue. It is worth noting that a level of 10% of significance was adopted and that only the correlation between gross revenue and maintenance was significant at 5% (Table 3).

Table 3. Spearman's correlation between the economic viability components of three cowpea crops in Cristalina – GO.

| | Area | Into. | Manut. | Depress. | Desp. | Cust. | Head. | Prod | Price. | Rec. |
|---|---|---|---|---|---|---|---|---|---|---|
| Area | 1,0 | | | | | | | | | |
| Into. | -1,0 | 1,0 | | | | | | | | |
| Manut. | 0,5 | -0,5 | 1,0 | | | | | | | |
| Depress. | -0,5 | 0,5 | 0,5 | 1,0 | | | | | | |
| Desp. | 1,0 | -1,0 | 0,5 | -0,5 | 1,0 | | | | | |
| Cust. | 1,0 | -1,0 | 0,5 | -0,5 | 1,0 | 1,0 | | | | |
| Head. | -0,5 | 0,5 | 0,5 | 1,0 | 0,5 | 0,5 | 1,0 | | | |
| Prod. | -0,5 | 0,5 | 1,0 | -0,5 | 0,5 | 0,5 | -0,5 | 1,0 | | |
| Prec. | -1,0 | 1,0 | 0,5 | 0,5 | 1,0 | 1,0 | 0,5 | 0,5 | 1,0 | |
| Rec. | -1,0 | 1,0 | -0,5 | | -1,0 | -1,0 | 0,5 | 0,5 | 1,0 | 1,0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0,5 | | | | | | |

Source: Authors, 2019

*The correlation is significant at the 10% significance level. **The correlation is significant at the 5% level of significance.

The average price was strongly correlated with the costs but in a negative way, that is, when there is an increase in costs, the average price is low. On the other hand, productivity was negatively correlated with most variables, except for inputs, indicating that the expenses spent on inputs result in higher grain yields (Table 3).

## CONCLUSION

The 2015/2016 harvest has higher productivity: 1,657.8 kg $^{ha-1}$ of cowpea and higher profitability: R$1,306.41.

The 2016/2017 and 2017/2018 harvests have yields of 1,059.00 and 971.25 kg $^{ha-1}$ of cowpea, respectively.

The 2016/2017 and 2017/2018 harvests have losses of R$-1,430.38 and R$-1,235.93, respectively.

The cultivation of cowpea in the Cerrado region must be aligned so that the producer obtains lower production costs, maximum grain yields and higher sales prices.

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