Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 108, No. 1, 2007, pages 51–58

Economic Viability of Small Scale Organic Production of Rice, Common Bean and Maize in Goias State, Brazil

A. E. Wander [*1], **A.D. Didonet** [2], **J. A. A. Moreira** [2], **F. P. Moreira** [2], **A. C. Lanna** [2], **J. A. F. Barrigossi** [2], **E. D. Quintela** [2] and **T. R. Ricardo** [2]

Abstract

This study was conducted to assess the economic feasibility of small scale organic production of rice, common bean and maize in Goias State, Brazil. During 2004/05 and 2005/06 growing seasons, rice, common bean and maize were produced at the organic farm of Embrapa Rice and Beans in five mulching systems (fallow, *Crotalaria juncea, Cajanus cajan, Mucuna aterrima* and *Sorghum bicolor*), with and without tillage. Soil tillage consisted of heavy disc harrowing followed by light disc harrowing. All operations and used inputs were recorded. Based on those records, the production costs for each crop were estimated for each cropping season. The costs included operations like sowing, ploughing, harrowing, spraying, fertilizer broadcasting and harvesting, as well as inputs like seeds, inoculant strains of Rhizobium, neem oil and organic fertilizers. The benefits include the gross revenue obtained by multiplying the production amount with the market price for non-organic products. For the purpose of analysis of competitiveness of organic production in comparison to conventional farming the market prices assumed were those of conventional production. In the analysis, the costs of certification were not considered yet due to lack of certifiers in the region. For comparison between traits, net revenue, the benefit-cost-ratio (BCR) and the break even point were used. In 2004/05 growing season the BCR varied from 0.27 for common bean on *S. bicolor* mulch system with tillage up to 4.05 for green harvested maize produced after *C. juncea* in no tillage system. Common bean and rice were not economically viable in this growing season. In 2005/06 growing season the BCR varied between 0.75 for common bean after *S. bicolor* in tillage system and 4.50 for green harvested maize produced after fallow in no tillage system. In this season common bean was economically viable in leguminous

* corresponding author

[1] Alcido Elenor Wander, Researcher at the National Rice and Beans Research Center of the Brazilian Agricultural Research Corporation (EMBRAPA), Assistant Lecturer at the School of Agronomy and Food Technology of the Federal University of Goias (UFG) and Professor at the Postgraduate Program of Regional Development of the Faculdades Alves Faria (ALFA). P.O. Box 179, 75375-000 Santo Antonio de Goias, GO, Brazil. E-mail: awander@cnpaf.embrapa.br

[2] Agostinho Dirceu Didonet, José Aloísio Alves Moreira, Fabio Pires Moreira, Anna Cristina Lanna, José Alexandre Freitas Barrigossi, Eliane Dias Quintela, Tiago Ribeiro Ricardo: National Rice and Beans Research Center of the Agricultural Research Corporation (EMBRAPA) and Professor at Goias State University. P.O. Box 179, 75375-000 Santo Antonio de Goias, GO, Brazil

mulching systems and green harvested maize was viable in all mulching systems.

Keywords: economic feasibility, organic farming, organic rice production, organic common bean production, organic maize production

1 Background and Objective of the Study

The increasing demand for healthy food and the need for environmental and economic sustainability of agricultural production organic farming is being promoted worldwide. Some studies carried out in Brazil pointed out a growing market for those products (MOREIRA *et al.*, 2005) and the need for additional production (LACERDA *et al.*, 2005).

Therefore, agricultural researchers are challenged to develop such systems together with farmers. In Brazil, scientists are testing different farming systems to produce organic food. However, the economic feasibility, which is a key factor for technology adoption and sustainable production, was not analysed yet.

Therefore, the main objective of this study was to assess the economic viability of small scale organic production of rice, common bean and maize in Goias State, Brazil.

2 Methods

The study was conducted in Santo Antonio de Goias, Goias State, Brazil. The soil type is a Typic Haplustox with 473 g/kg of clay, 190 g/kg of silt and 336 g/kg of sand in the top 30 cm. According to classification of Köppen, the research area is characterized by an Aw climate (tropical seasonal savannah). The annual average of pluvial precipitation is of 1,461.8 millimetres. The rainy season lasts from October to April, and the dry season from May to September. The annual average air temperature is 22.6 °C. The monthly average temperature varies from 14.2 °C in June to 31.3 °C in September.

During 2004/05 and 2005/06 growing seasons, upland rice, common bean and maize were produced at the organic farm (MAPA-BRASIL, 2004) of Embrapa Rice and Beans under five mulching systems (fallow, sunn hemp [*Crotalaria juncea*], pigeon pea [*Cajanus cajan* (L.) Millsp], velvet bean [*Mucuna aterrima* (Piper et Tracy) Holland] and sorghum [*Sorghum bicolor* (L.) Moench]), with and without tillage. All carried out operations and used inputs were recorded. Based on those records, the production costs for each crop were estimated in each cropping season. The costs include operations like sowing, ploughing, harrowing, weeding, spraying and harvesting, as well as inputs like seeds, inoculant strains of Rhizobium, neem oil and organic fertilizers. The benefits include the gross revenue obtained by multiplying the production amount with the market price for non-organic products, as there are no established certification procedures for organic production in the study region. Thus, for the purpose of analysis of competitiveness of organic production in comparison to conventional farming, the market prices assumed were those of conventional production. In the analysis, the costs of certification were not considered yet due to lack of certifiers in the region. For comparison between treatments, the net revenue (NR), the benefit-cost-ratio (BCR) and the break even point (BEP) were used.

NR is the difference obtained when subtracting the total cost from the gross revenue (Gittinger, 1982) and can be obtained as follows:

$$NR = \left(\sum_{t=0}^{n} R_t/q^t\right) - \left(\sum_{t=0}^{n} C_t/q^t\right) \quad (1)$$

where R is the gross revenue, C is the total cost, i is the interest rate, and n is the number of years, and $q^t = (1+i)^t$. If $NR > 0$, then the gross revenue is greater than the total cost, if $NR = 0$, than the gross revenue is equal to the total cost, and if the $NR < 0$, than the gross revenue is less than the total cost. In this study, NR is measured in Brazilian Reais (R$) and is based on one hectare.
BCR is the ratio obtained when the present worth of the benefit stream is divided by the present worth of the cost stream (GITTINGER, 1982; NORONHA, 1987) and can be obtained as follows:

$$BCR = \frac{\sum_{t=0}^{n} R_t/q^t}{\sum_{t=0}^{n} C_t/q^t} \quad (2)$$

where R is the gross revenue, C is the total cost, i is the interest rate, and n is the number of years, and $q^t = (1+i)^t$. If $BCR > 1$, then the gross revenue is greater than the total cost, if $BCR = 1$, than the gross revenue is equal to the total cost, and if the $BCR < 1$, than the gross revenue is less than the total cost.

BEP is the level where the gross revenue is equal to the total cost and can be obtained as follows:

$$GR_{cr} = C_{cr} \quad (3)$$

where GR is the gross revenue obtained with crop cr, calculated by multiplying its yield y_{cr} by its market price p_{cr}, and the C is the total cost obtained by multiplying the amount of used inputs by its prices. In this study, the BEP for yield and for product price are considered.

3 Results and Discussion

3.1 The Gross Revenue

In Table 1 the gross revenues obtained per hectare for different treatments are presented. Gross revenue is one important input for the further analysis and can not be used alone for discussion.

3.2 The Production Costs

Table 2 shows the total production costs per hectare for each different treatment. The total production costs represent another important input for the further analysis and can not be used alone for discussion.

3.3 The Net Revenue

Table 3 shows the net revenue (NR) per hectare for each different treatment. The net revenue per hectare is one of the indicators used for analysis. Considering the net revenue per hectare, green maize and maize grain achieved the highest performance. Common

Table 1: Gross revenue (R$/ha) of organic production of common bean (*Phaseolus vulgaris*), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Gross revenue (R$/ha) in different mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	719.76	1,201.74	982.33	859.94	760.20
		2005/2006	2,286.00	2,183.00	2,295.50	2,225.85	1,623.60
	Without	2004/2005	1,034.28	1,643.97	1,386.75	1,506.23	1,110.12
		2005/2006	1,306.80	1,892.85	2,063.85	2,103.35	1,571.10
Upland rice	With	2004/2005	605.20	1,104.50	874.01	547.42	304.80
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	5,424.76	6,317.21	7,703.45	7,265.35	4,401.65
		2005/2006	5,754.00	5,495.75	6,361.75	6,836.50	4,122.50
	Without	2004/2005	4,161.01	6,465.27	4,126.42	6,779.34	3,231.32
		2005/2006	5,261.00	5,330.25	5,363.00	6,122.50	3,813.50
Maize grain	With	2004/2005	1,987.95	2,274.06	2,329.13	2,151.03	867.10
		2005/2006	1,408.55	2,180.88	2,463.22	2,760.99	807.02
	Without	2004/2005	1,055.84	2,004.01	1,874.16	2,399.21	887.57
		2005/2006	1,480.16	1,679.40	1,925.39	2,902.15	1,011.47

Table 2: Production costs (R$/ha) of organic production of common bean (Phaseolus vulgaris), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Production costs (R$/ha) in diff. mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	2,226.89	2,522.89	2,522.89	2,562.89	2,766.89
		2005/2006	1,638.11	1,934.11	1,934.11	1,974.11	2,178.11
	Without	2004/2005	1,909.59	2,205.59	2,205.59	2,245.59	2,449.59
		2005/2006	1,320.81	1,616.81	1,616.81	1,656.81	1,860.81
Upland rice	With	2004/2005	1,671.50	1,967.50	1,967.50	2,007.50	2,211.50
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	1,607.40	1,903.40	1,903.40	1,943.40	2,147.40
		2005/2006	1,485.60	1,781.60	1,781.60	1,821.60	2,025.60
	Without	2004/2005	1,290.10	1,586.10	1,586.10	1,626.10	1,830.10
		2005/2006	1,168.30	1,464.30	1,464.30	1,504.30	1,708.30
Maize grain	With	2004/2005	1,527.40	1,823.40	1,823.40	1,863.40	2,067.40
		2005/2006	1,485.60	1,781.60	1,781.60	1,821.60	2,025.60
	Without	2004/2005	1,210.10	1,506.10	1,506.10	1,546.10	1,750.10
		2005/2006	1,168.30	1,464.30	1,464.30	1,504.30	1,708.30

* Yields were to low to justify harvesting.

beans where only economically viable in season 2005/2006, but not on sorghum mulch, with or without tillage, and on fallow mulch without tillage. Rice was not viable. Green maize instead had quite high net revenues, up to R$ 5,800 per hectare and was viable on all mulching systems, with or without tillage. Maize grain was viable on leguminous mulches in both years, with or without tillage.

Table 3: Net revenue (R$/ha) of organic production of common bean (*Phaseolus vulgaris*), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Net revenue (R$/ha) in different mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	(1,507.13)	(1,321.15)	(1,540.56)	(1,702.95)	(2,006.69)
		2005/2006	647.89	248.89	361.39	251.74	(554.51)
	Without	2004/2005	(875.31)	(561.62)	(818.84)	(739.36)	(1,339.47)
		2005/2006	(14.01)	276.04	447.04	446.54	(290.71)
Upland rice	With	2004/2005	(1,066.30)	(863.00)	(1,093.49)	(1,460.08)	(1,906.70)
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	3,817.36	4,413.81	5,800.05	5,321.95	2,254.25
		2005/2006	4,268.40	3,714.15	4,580.15	5,014.90	2,096.90
	Without	2004/2005	2,870.91	4,879.17	2,540.32	5,153.24	1,401.22
		2005/2006	4,092.70	3,865.95	3,898.70	4,618.20	2,105.20
Maize grain	With	2004/2005	460.55	450.66	505.73	287.63	(1,200.30)
		2005/2006	(77.05)	399.28	681.62	939.39	(1,218.58)
	Without	2004/2005	(154.26)	497.91	368.06	853.11	(862.53)
		2005/2006	311.86	215.10	461.09	1,397.85	(696.83)

* Yields were to low to justify harvesting.

3.4 The Benefit-Cost-Ratio

The benefit-cost-ratios are presented in Table 4. Common bean's economic performance in cropping season 2005/2006 was superior to 2004/2005. While in 2004/2005 none of the common bean treatments achieved $BCR > 1$, in 2005/2006 all treatments under leguminous mulching (*C. juncea, C. cajan* and *M. aterrima*) reached $BCR \geq 1.13$. In 2005/2006 also on fallow area with tillage the BCR was 1.4. Sorghum as mulch for common bean production was not a viable option in none of the two years considered (Table 4).

The upland rice production had the worst economic performance in organic farming. In 2004/2005 only in tillage systems its harvest was justified by yields and the BCR were all below 0.57. The low yields achieved under the considered conditions were the cause of insufficient economic performance (Table 4).

The green maize production achieved the highest BCR, varying from 1.77 on *S. bicolor* mulch in season 2004/2005 up to 4.50 on fallow mulch in season 2005/2006. Thus, green maize production was viable under all considered systems (Table 4).

Table 4: Benefit-Cost-Ratio of organic production of common bean (*Phaseolus vulgaris*), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Benefit-Cost-Ratio in different mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	0.32	0.48	0.39	0.34	0.27
		2005/2006	1.40	1.13	1.19	1.13	0.75
	Without	2004/2005	0.54	0.75	0.63	0.67	0.45
		2005/2006	0.99	1.17	1.28	1.27	0.84
Upland rice	With	2004/2005	0.36	0.56	0.44	0.27	0.14
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	3.37	3.32	4.05	3.74	2.05
		2005/2006	3.87	3.08	3.57	3.75	2.04
	Without	2004/2005	3.23	4.08	2.60	4.17	1.77
		2005/2006	4.50	3.64	3.66	4.07	2.23
Maize grain	With	2004/2005	1.30	1.25	1.28	1.15	0.42
		2005/2006	0.95	1.22	1.38	1.52	0.40
	Without	2004/2005	0.87	1.33	1.24	1.55	0.51
		2005/2006	1.27	1.15	1.31	1.93	0.59

* Yields were to low to justify harvesting.

When harvesting maize as grain, all systems under leguminous mulching, with or without tillage, were economically viable, with BCR varying from 1.15 to 1.93. The fallow system was only viable with tillage in 2004/2005 and without tillage in 2005/2006. Sorghum was not economically viable as mulch for maize grain production (Table 4).
The differences in economic performance between green and maize grain are revenue based, considering the higher yields and the market prices for green maize, as the production costs are similar to maize grain.
Obviously the economic performance of each crop would be increased if consumers were willing to pay more for organic products. In this case the costs of certification would also increase the production costs.

3.5 The Break Even Point

Table 5 shows the break even point of yield for each treatment. Green and maize grain are again those crops with best performance as their break even points for yield are far below the obtained yields.

The market prices for common beans were R$ 1.20/kg in 2004/2005 and R$ 1.50/kg in 2005/2006. For rice, the prices were R$ 0.40/kg in 2004/2005 and R$ 0.33/kg in 2005/2006. For maize, the prices were R$ 0.34/kg for maize grain in both years and R$ 0.50/kg for green maize also in both years.

The break even points for product price are presented in Table 6. It can be seen, again, that green maize shows the break even point for price far below the market price.

Table 5: Break even point (kg/ha) of organic production of common bean (*Phaseolus vulgaris*), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Break even point (kg/ha) in diff. mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	1,855.7	2,102.4	2,102.4	2,135.7	2,305.7
		2005/2006	1,092.1	1,289.4	1,289.4	1,316.1	1,452.1
	Without	2004/2005	1,591.3	1,838.0	1,838.0	1,871.3	2,041.3
		2005/2006	880.5	1,077.9	1,077.9	1,104.5	1,240.5
Upland rice	With	2004/2005	4,178.8	4,918.8	4,918.8	5,018.8	5,528.8
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	3,214.8	3,806.8	3,806.8	3,886.8	4,294.8
		2005/2006	2,971.2	3,563.2	3,563.2	3,643.2	4,051.2
	Without	2004/2005	2,580.2	3,172.2	3,172.2	3,252.2	3,660.2
		2005/2006	2,336.6	2,928.6	2,928.6	3,008.6	3,416.6
Maize grain	With	2004/2005	4,492.4	5,362.9	5,362.9	5,480.6	6,080.6
		2005/2006	4,369.4	5,240.0	5,240.0	5,357.7	5,957.7
	Without	2004/2005	3,559.1	4,429.7	4,429.7	4,547.4	5,147.4
		2005/2006	3,436.2	4,306.8	4,306.8	4,424.4	5,024.4

Table 6: Break even point (R$/ha) of organic production of common bean (*Phaseolus vulgaris*), upland rice (*Oryza sativa*) and maize (*Zea mays*) under five mulching systems with and without tillage in cropping seasons 2004/2005 and 2005/2006.

			Break even point (k$/ha) in diff. mulching systems				
Crop	*Tillage*	*Season*	*Fallow*	*C.juncea*	*C.cajan*	*M.aterrima*	*S.bicolor*
Common beans	With	2004/2005	3.71	3.39	4.13	4.13	4.37
		2005/2006	1.07	1.46	1.58	1.71	2.01
	Without	2004/2005	2.22	1.95	2.40	2.23	2.65
		2005/2006	1.52	1.47	1.59	1.51	1.78
Upland rice	With	2004/2005	1.10	0.99	1.26	1.85	2.90
		2005/2006*	–	–	–	–	–
	Without	2004/2005*	–	–	–	–	–
		2005/2006*	–	–	–	–	–
Green maize	With	2004/2005	0.15	0.16	0.13	0.14	0.24
		2005/2006	0.13	0.17	0.15	0.14	0.25
	Without	2004/2005	0.16	0.13	0.21	0.13	0.28
		2005/2006	0.11	0.14	0.15	0.13	0.22
Maize grain	With	2004/2005	0.26	0.32	0.30	0.31	0.81
		2005/2006	0.36	0.31	0.30	0.27	0.85
	Without	2004/2005	0.39	0.30	0.32	0.25	0.67
		2005/2006	0.27	0.35	0.36	0.21	0.57

* Yields were to low to justify harvesting.

4 Conclusions and Policy Implications

Organic farming can be a viable option even if the producer prices are the same than those of conventional food.

Upland rice was not economically viable under the considered conditions. Organic common bean production was economically feasible only in the second of the two years considered and mainly in leguminous mulching systems. Maize had the best economic performance under all considered options and cultivation systems. The best results were obtained with green maize cultivated in leguminous mulching systems.

As rice and beans are staple food for Brazilian population, there should be established incentives in order to enable its viable organic production. There may be a demand for certification in the region. In this case, additional studies should be carried out considering the situation where certification is being carried out, with higher costs and product prices.

Acknowledgement
This study has been financially supported by the Brazilian National Council for Scientific and Technological Development (CNPq).

References

Gittinger, J. P.; *Economic analysis of agricultural projects*; Baltimore, London: The Johns Hopkins University Press; 1982.

Lacerda, A. C. V., Freitas, F. C., Wander, A. E., Didonet, C. C. G. M. and Didonet, A. D.; A importância atribuída pelos consumidores de alimentos orgânicos à certificação e à marca; In: II Congresso de Pesquisa. Ensino e Extensão da UFG: A vida diante das novas tecnologias, 03 a 07 de Outubro de 2005, Goiânia; Anais...; Goiânia: UFG; 2005.

MAPA-Brasil; Instrução Normativa n° 16, de 11 de junho de 2004. Estabelece os procedimentos a serem adotados, até que se concluam os trabalhos de regulamentação da Lei n° 10.831, de 23 de dezembro de 2003, para registro e renovação de registro de matérias-primas e produtos de origem animal e vegetal, orgânicos, junto ao Ministério da Agricultura, Pecuária e Abastecimento – MAPA; Diário Oficial da União, Brasília, DF; p.4, 14 de junho de 2004, Seção 1; Ministério da Agricultura, Pecuária e Abastecimento – MAPA; Diário Oficial da União, Brasília, DF; p.4, 14 de junho de 2004, Seção 1; 2004.

Moreira, C. A., Fernandes, P. M. and Marin, J. O. B.; A dinâmica da cadeia produtiva dos produtos orgânicos em Goiânia – GO e entorno; In: II Congresso de Pesquisa, Ensino e Extensão da UFG: A vida diante das novas tecnologias, 03 a 07 de Outubro de 2005, Goiânia; Anais... Goiânia: UFG; 2005.

Noronha, J. F.; *Projetos agropecuários: administração financeira, orçamento e viabilidade econômica*; São Paulo-SP: Atlas; 1987.