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Economic analysis of the intercropping of lettuce and tomato in different seasons under protected cultivation

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ABSTRACT

Lettuce and tomato are vegetables that can be grown in protected cultivation, under given conditions. Considering their expensive production systems, intercropping might be an excellent alternative to optimize costs. Four experiments were carried out at the São Paulo State University (UNESP), at Jaboticabal, Brazil, to study the economic viability of intercropping lettuce and tomato under protected cultivation. To set the intercropping, lettuce was transplanted 0, 10, 20, and 30 days after transplanting (DAT) tomato and vice-versa, in two seasons, namely April to September 2003 and January to June 2004, when monocultures of both vegetables were also carried out. At the first planting season, operational profits (OP) in intercropping (lettuce transplanted 0, 10, and 20 DAT tomato) were higher than in monocultures. At the first season, the return rates (RR) and OP were very much alike, whereas at the second season, RR in intercropping were lower than in monoculture. Transplanting tomato after lettuce, at both the first and second seasons, resulted in higher OP than those in monocultures. RR, OP and the profitability index (PI) were higher at the first than at the second season, independent of the growing system. RR in intercropping, independently of the intercropping schedule, were higher than in monoculture. In general, PI of tomato in monoculture and in intercropping were quite similar and both were higher than PI in the monoculture of lettuce. The economic indexes confirmed the agronomic viability (expressed by the index of area use efficiency) of transplanting lettuce and tomato simultaneously in both growing seasons; transplanting lettuce 10 and 20 DAT tomato, in the second season; and transplanting tomato after lettuce in all studied schedules. The economic indexes reached their peaks when tomato and lettuce were transplanted at the same day, in the first growing season (in average): OP of BRL$ 12,948.63 (US$ 4,273.48) in 614.4 m^{-2}; RR of 6.7% and IP of 85%.

Keywords: *Lactuca sativa*, *Lycopersicon esculentum*, intercropping, protected cultivation, economic feasibility, profitability.

RESUMO

Análise econômica de consórcios de alface e tomate estabelecidos em diferentes épocas em ambiente protegido

A alface e o tomate são hortaliças que, em determinadas condições, podem ser cultivadas em ambiente protegido. Sob esta condição de cultivo, consorciá-las é uma alternativa para otimizar custos. Avaliou-se a viabilidade econômica de quatro cultivos consorciados de alface e tomate, em ambiente protegido, na UNESP, em Jaboticabal-SP. Os consórcios foram estabelecidos pelo transplante de alface 0, 10, 20 e 30 dias após o transplante (DAT) do tomate e vice-versa, em duas épocas (abril a setembro de 2003 e janeiro a junho de 2004), assim como monoculturas das duas hortaliças. Quando a alface foi transplantada 0, 10 e 20 dias após o transplante (DAT) do tomate, na primeira época de cultivo, e 0 DAT, na segunda época, os lucros operacionais (LO) foram superiores ao observado nas monoculturas. As taxas de retorno (TR), no primeiro cultivo, apresentaram o mesmo comportamento de LO, enquanto, na segunda época, TR dos consórcios foram inferiores às das monoculturas. Consórcios com o transplante do tomate após alface, na primeira e segunda época de cultivo, apresentaram LO superiores aos das monoculturas. TR de consórcios foram superiores às de monoculturas, independentemente da época em que foram estabelecidos. Os índices de lucratividade (IL) da monocultura de tomate foram muito próximos aos do consórcio e maiores do que os da monocultura de alface. Os consórcios e monoculturas da primeira época apresentaram maiores TR, IL e LO do que na segunda época. Os indicadores econômicos ratificaram a viabilidade produtiva (expressa pelo índice de uso eficiente da área) dos consórcios com transplante de alface e tomate simultaneamente, nas duas épocas; alface 10 e 20 DAT após tomate, na primeira época e; todos os consórcios com transplante de tomate após a alface. O melhor resultado econômico foi obtido no plantio de abril a setembro com transplantes das duas culturas na mesma data. Para essa condição, foram obtidos os maiores índices: LO médio de R$ 12.948,63 em 614,4 m^2; TR médio de 6,7% e IL médio de 85%.

Palavras-chave: *Lactuca sativa*, *Lycopersicon esculentum*, cultivo consorciado, ambiente protegido, viabilidade econômica, rentabilidade.

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Intercropping is a cultivation system in which two or more crops grow concurrently in the same area for at least part of their cycles (Cecilio Filho & May, 2002). Intercropping has direct benefits, such as the increase in food production per cultivated area in comparison to single cropping; as well as indirect benefits, as the improvement of the biological diversity and reduction in labor and environmental impacts due to the smaller area that is diverted to cultivation. In addition, intercropping can increase profitability, especially as consequence of the more efficient use of the applied inputs, including machine hours and the energy spent in food production.

The advantages of intercropping over single cropping are usually demonstrated by indexes that assess the area use efficiency. Nevertheless, this is not enough. To disclose the superiority of intercropping over single cropping beyond doubt, the economic analysis should also be considered (Zanatta *et al*., 1993). Farmers must undertake continuous efforts to improve their production efficiency, focusing more intensively on what takes place inside the farm. In this perspective, the analysis of production costs gains relevance as agriculture becomes more and more competitive (Martin *et al*., 1998).

Vegetables have variations in commercial characteristics, prices, and production costs throughout the year (Rao *et al*., 2005a,b). The analysis of the seasonal variation of tomato prices in the wholesale market of São Paulo (CEAGESP) in the period 1995-99 showed that the prices paid for the 24 kg tomato container were higher from February to April and lower from April to June (Camargo Filho & Mazzei, 2000). In the same years, Camargo Filho & Mazzei (2001) found that the prices for the three lettuce groups, namely crisp, butter, and head lettuce, were higher in January and February and lower from June to September, due to the usually larger supply in the latter period. Because of the seasonality of prices, highest yields not always result in higher profitability, either in single or intercropping. For the second, this is especially true when yield reduces significantly in one of the intercropped species. Rao *et al*. (2005c) found that in the intercropping of lettuce and tomato, although the indexes for area use efficiency showed a large superiority (up to 79%) of intercropping over monoculture, the figures were not that comfortable when it comes to profitability. The authors attributed the lack of proportionality between the two parameters to the low values paid for lettuce, which contributed with merely 7% to the intercropping gross revenue. On the other hand, if the intercropping did not show high profitability in relation to the tomato single cropping, it exceeded by far the monoculture of lettuce, which was not economically viable (negative operating profit).

For an adequate analysis of the economic viability of intercropping, one should seek the actual production cost. Classically, the production cost is defined as the sum of the values of all services and factors used in the production of a good, which is equivalent to the total value of the monetary sacrifice of the agent that produces. Therefore, all factors used to produce a particular good should be paid, including the fixed costs (Matsunaga *et al*., 1976). Rezende *et al*. (2005a) reported a total operating cost for lettuce production, under protected cultivation (625 m^2), of BRL$ 539.03 (US$ 177.90[1]), while Rodrigues *et al*. (1997) observed a total operating cost, also under protected cultivation (350 m^2), of BRL$ 311.06 (US$ 102.67[i]). However, the crop economic viability may be altered by a range of factors, including crop management (Rezende *et al*., 2005c) and planting season (Tarsitano *et al*., 1999; Costa *et al*., 2005). The methodology of the production operating cost consists, in short, on gathering all variable items, represented by their costs in expended currency, plus some short term fix costs represented by the depreciation of the equipment and facilities used in the production. This approach avoids the need of using subjective criteria, since the main purpose of the operating cost is to be an indicator, as accurate as possible, for decision-making (Matsunaga *et al*., 1976).

The objective of this study was to study the economic viability of intercropping lettuce and tomato, in two growing seasons, under protected cultivation.

MATERIAL AND METHODS

The yield of tomato and lettuce, as well as the indexes for area use efficiency were obtained in four experiments carried out at the São Paulo State University (UNESP), *campus* of Jaboticabal. The experiments were set in pairs, in two seasons, as follows:

(a) Experiments 1 and 2: carried out from April 17 to September 9, 2003 (1st growing season) and from January 30 to May 27, 2004 (2nd growing season), using tomato and lettuce as main and secondary crops, respectively. Lettuce was transplanted 0, 10, 20 and 30 days after transplanting (DAT) tomato. For each transplanting date in the intercropping there was a correspondent lettuce monoculture, meant for assessing all possible environmental influences over the plant performance. For both experiments, tomato was transplanted at the same date for both inter- and single-cropping;

(b) Experiments 3 and 4: carried out from April 17 to September 23, 2003, and from January 30 to June 24, 2004, to evaluate the transplant of tomato after lettuce, using the same time intervals adopted for lettuce in experiments 1 and 2. Lettuce inter- and single-crops were transplanted in the same day.

Tomato and lettuce were allocated to six plots of 48.0 x 1.2 m (length, width) in a 48.0 x 12.8 m (length, width) greenhouse (614.4 m^2). Lettuce, cultivar Vera, crisp type, was transplanted at the spacing of 0.30 x 0.25 m, resulting in a stand of 4,530 plants, while for tomato, cultivar Deborah Max, we used a double-row spacing of 1.20 x 0.60 x 0.50 m, which resulted in a stand of 1,132 plants. Cultivation practices were the same in all experiments. The area was cleared only with herbicides, using a 20-L backpack sprayer, and then prepared using a three 26'' disc plow. Beds were raised with a 1.20 m wide seedbed tiller, with six spades. Weeding was carried out by hand hoeing both in seedbeds and aisles, four and three times for tomato and lettuce in monoculture, respectively, and four times in the intercropped plots. Six and three side-dressings were applied for tomato and lettuce, respectively, independent of the cropping system. Fungicides were sprayed four times in lettuce, in both seasons, and 35 and 30 times in tomato in the first and second growing seasons, respectively. No other pesticides were used. Tomato plants were driven using plastic ribbons, and submitted to sprout thinning and top-pruning.

For both crops, we used drip-irrigation, spaced at 10 cm, two and four rows of drippers for respectively tomato and lettuce. In the intercropping system, we used four rows of drippers. The irrigation did not demand moving the drippers. Therefore, to estimate labor, we took into account only the time required to switch the system on and off, and to perform repairs. The irrigation time was taken in average as 30 minutes per day throughout the crop cycle, both in single and intercropping. The post-harvest activities considered were washing, grading and packaging according to market standards. All production costs were estimated assuming a continuously cultivated greenhouse.

The total operating costs (TOC) for each growing season, both for single and intercropping, were estimated according to Matsunaga *et al.* (1976), as also adopted by the Institute of Agricultural Economics (IEA). This methodology considers the actual disbursements made during the production cycle, covering costs with labor, inputs and machine transit, as well as repairs, maintenance and depreciation of the equipments, implements and facilities used for production.

The nominal prices of all items needed for production in April 2003 (beginning of the 1st growing season) and January 2004 (beginning of the 2nd growing season) were corrected to actual values of May 2005, in Brazilian Reais (BRL$), by the General Price Index (GPI). The TOC of each crop was estimated using the technical coefficients established during the experiments. The technical coefficients for general tillage operations, i.e., weeding, plowing and seedbed raising (Table 1) were based on Brancalião (1999). The estimate of TOC did not allow for costs with commercialization.

The unit values of each item, referring to May 2005, were estimated as follows:

(a) Labor: wages were established according to the values recommended by the Union of Rural Workers of Jaboticabal and refer to May 2005: BRL$ 335.00 and 424.24 (US$ 110.56[i] and 140.00[i]), respectively for ordinary workers and tractor drivers, with a monthly workload of 200 hours, for both growing seasons. Social security contributions made by employers represented 43% of the salary. Thus, for the two growing seasons, the estimated hour-cost were BRL$ 2.40 and 3.03 (US$ 0.80[i] and 1.00[i]) for ordinary work and tractor driving, respectively;

(b) Hour-cost for equipments and implements (Table 2): equipment hour-cost (EHC) included fuel expenses plus an additional value for repairs, maintenance, parking, and insurance. The implement hour-cost (IHC) included grease and repairs. The actual EHC, including IHC, for a Massey Ferguson 275 72HP was BRL$ 9.69 and 9.77 (US$ 3.20[i] and 3.22[i]), for the first and second seasons, respectively, and were estimated as follows:

(1) EHC = i + p + r + m + f, and;

(2) IHC = r + g, where;

i = insurance, 0.75% of the equipment value, per year;

p = parking, 1% of the equipment or implement value, per year;

r = repair, 10% of the equipment or implement value, per year;

m = maintenance, equivalent to BRL$ 1.99 (US$ 0.65[i]) and 2.01 h^{-1} for the first and second growing season, respectively;

f = fuel, equivalent to 5.8 and 6.1 L h^{-1} when dragging the seedbed tiller or

Table 1. Technical coefficients and costs of equipments and implements used to grow tomato and lettuce in single and intercropping, under protected cultivation, in Brazilian Reais (BRL$)[1] corrected[2] for May, 2005 (coeficientes técnicos e custo de máquinas e implementos para o cultivo solteiro e em consórcio de tomate e alface, em ambiente protegido, em reais (R$)[1] corrigidos[2] para maio de 2005). Jaboticabal, UNESP, 2009.

Agricultural practices	Tomato		Lettuce		Tomato x lettuce	
	Time spent (h)	Activity cost (BRL$)[1]	Time spent (h)	Activity cost (BRL$)[1]	Time spent (h)	Activity cost (BRL$)[1]
First season						
Land clearing[3]	0.30	0.045	0.30	0.045	0.30	0.045
Plowing[4]	0.25	5.27	0.25	5.27	0.25	5.27
Seedbed raising[5]	0.85	18.39	0.85	18.39	0.85	18.39
Pesticide spraying[6]	64.75	9.71	7.40	1.11	64.75	9.71
Irrigation[7]	76.00	11.40	26.00	3.90	76.00	11.40
Manual harvest[8]	28.00	24.08	5.40	4.65	33.40	28.72
Total 614.4 m^{-2}	**170.15**	**68.90**	**40.2**	**33.37**	**175.55**	**73.55**
Second season						
Land clearing[3]	0.30	0.045	0.30	0.045	0.30	0.045
Plowing[4]	0.25	5.28	0.25	5.28	0.25	5.28
Seedbed raising[5]	0.85	18.56	0.85	18.56	0.85	18.56
Pesticide spraying[6]	55.50	8.34	7.40	1.11	55.50	8.33
Irrigation[7]	65.00	9.10	21.00	2.94	65.00	9.10
Manual harvest[8]	28.00	22.96	5.40	4.43	33.40	27.39
Total 614.4 m^{-2}	**149.90**	**64.28**	**35.20**	**32.37**	**155.30**	**68.70**

[1]US$ 1.00 = BRL$ 3.03, May, 2005 (US$ 1,00 = BRL$ 3,03, maio de 2005); [2]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)); [3,6]Herbicides applied using a backpack sprayer, 20 L (herbicidas aplicados utilizando pulverizador costal, 20 L); [4]Tractor 72 HP + plow 3 26”-disks (trator 72 CV + arado de 3 discos com 26’’); [5]Tractor 75 HP + seedbed tiller (trator 75 CV + rotoencanteirador); [7]Motorpump 1 HP (motobomba 1 CV); [8]Wheel barrel (carrinho de mão).

the plow, respectively;

g = grease, calculated as the consumption (kg m^{-1}) x price;

(c) Input prices: the nominal input prices in Jaboticabal were corrected to actual prices as stated before (Table 2);

(d) Depreciation (Table 2): the depreciation was calculated using the linear method, in which the good is depreciated during its life at a constant rate, according to the following: D = (IV-RV)/NH, where: D = depreciation in \$ $year^{-1}$, IV = initial value (new good); RV = residual value; N = life (years) and, H = hours of use per year. The residual value for the tractor was taken as 20% of a new tractor, while no residual value was considered for the implements.

The prices of tomato and lettuce used for estimating the gross income were the average price practiced at the Terminal Wholesale Market of São Paulo (CEAGESP, 2005) from 2000 to the month of harvest, in 2004, corrected to actual values of May 2005 by the General Price Index (GPI). These prices included additional 30% for costs of packing, shipping, loading and unloading, rural social security and fees.

The average prices paid for lettuce in March, April, May, June, and July were BRL\$ 1.22 (US\$ 0.40[i]), 1.20 (US\$ 0.39[i]), 1.43 (US\$ 0.47[i]), 1.54 (US\$ 0.50[i]) and 1.27 kg^{-1} (US\$ 0.42[i]), respectively. For, tomato, the average prices were BRL\$ 1.21 (US\$ 0.40[i]), 1.05 (US\$ 0.35[i]), 0.97 (US\$ 0.32[i]), 1.01 (US\$ 0.33[i]), 1.03 (US\$ 0.34[i]) and 1.06 kg^{-1} (US\$ 0.35[i]), respectively in April, May, June, July, August, and September. The gross income (GI) of the different growing systems was calculated according to the following:

(a) Experiments 1 and 2: for tomato, we calculate the average of the prices paid during the months of harvest, namely July to September and April to June, for respectively the first and second seasons. For lettuce, we used the average of the prices received at the harvest dates, namely June 2, 17 and 27, July 8, 2003, in the first season, and March 13, 19 and 29, and April 15, 2004, in the second season, corresponding to lettuce transplanted respectively 0, 10, 20 and 30 DAT tomato in both seasons. The GI of the intercropping established by transplanting lettuce 30 DAT tomato in the first season, and 20 and 30 DAT tomato, in the second season, resulted exclusively from tomato sales, since the lettuce produced at this dates did not reach the commercial standard;

(b) Experiments 3 and 4: for lettuce,

Table 2. Inputs, useful life and annual use of implements, and grease used to grow tomatoes and lettuce in single and intercropping, under protected cultivation, in Brazilian Reais (BRL\$)[1] corrected[2] for May, 2005 (insumos, vida útil e uso ao ano de implementos e consumo de graxa para o cultivo solteiro e em consórcio de tomate e alface, em ambiente protegido, em reais (R\$)[1] corrigidos[2] para maio de 2005). Jaboticabal, UNESP, 2009.

Implements and inputs	Description/ trademark	Unit	Useful life (years)	Annual use	Grease (kg h^{-1})	1st season		2nd season	
						Price (BRL\$)[1,2]	Hour-cost (BRL\$)[1,2]	Price (BRL\$)[1,2]	Hour-cost (BRL\$)[1,2]
Tractor	MF (272 cv)	Unit	10	1000 h	0.05	65,594.29	9.69	66,071.59	9.77
Plow	3 26'' discs	Unit	7	480 h	0.04	4,172.54	1.20	3,509.42	1.05
Seedbed tiller	Lavrale	Unit	8	480 h	0.06	8,278.91	2.25	8,436.83	2.26
Backpack sprayer	Jato (20 L)	Unit	5	120 h	-	179.54	0.15	177.89	0.15
Wheel barrel	-	Unit	4	270 h	0.09	167.62	0.86	170.82	0.82
Motorpump	1 hp	Unit	10	30 h	-	444.87	0.15	415.74	0.14
Drip line	Netafilm	m	2	720 h	-	0.60	-	0.61	-
Styrofoam tray	128 cells	Unit	2	3 cycles	-	4.99	-	5.08	-
Styrofoam tray	288 cells	Unit	2	7 cycles	-	4.99	-	4.83	-
Smooth wire	nº 14	kg	-	-	-	4.94	-	4.94	-
Plastic ribbon	White	kg	-	-	-	7.48	-	6.91	-
Grease	-	kg	-	-	-	8.83	-	8.39	-
Diesel	-	L	-	-	-	1.67	-	1.69	-
Ammonium Nitrate	-	50 kg	-	-	-	67.33	-	64.87	-
Potassium (KCl)	-	50 kg	-	-	-	54.86	-	52.86	-
Single superphos-phate	-	50 kg	-	-	-	22.94	-	23.38	-
Tomato seeds	Débora Max	10 g	-	-	-	227.42	-	231.76	-
Lettuce seeds	Vera	100 g	-	-	-	39.90	-	39.64	-
Greenhouse	Masonry	m^2	10	365 days	-	11.97	-	12.20	-

[1]US\$ 1.00 = BRL\$ 3.03, May, 2005 (US\$ 1,00 = R\$ 3.03, maio de 2005); [2]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)).

which was transplanted in a single day, the harvests were carried out on June 2, and March 13, respectively for crops established on April 17, 2003, and January 30, 2004. For tomato, the GI was estimated as described for lettuce in experiments 1 and 2. In the first season, tomato harvests took place from July to August, when tomato was transplanted 0 and 10 days after lettuce, and from July to September, when transplanted 20 and 30 days after lettuce. In the second season, tomato harvests were carried out from April to June, independent of the transplanting date.

To assess the efficiency of the intercropping systems, we used the operating profit (OP), calculated as the difference between GI and TOC (Martin *et al*., 1998); the return rate (RR), which is the reason between GI and TOC; and the profitability index (PI), corresponding to the ratio between net and gross income and presented as the relationship between OP and GI, in percentage. PI shows the rate of available income for the activity after paying all operating costs (Martin *et al*., 1998).

RESULTS AND DISCUSSION

Based on the technical coefficients and income from lettuce when the vegetable was grown as single crop, in both the first and second growing seasons (Tables 3 and 4), the total operating costs (TOC) were estimated, respectively, in BRL$ 596.56 and 566.99 (US$ 196.89 and 187.13[i]) to a 614.4 m^2 greenhouse. Rezende *et al*. (2005a) and Robinson *et al*. (1997) observed lettuce TOC of BRL$ 539.03 (US$ 117.90[i]) in 625 m^2 and BRL$ 311.06 (US$ 102.66[i]) in 350 m^2, respectively, both in greenhouse. The difference in lettuce TOC between the two seasons was very small. In both growing seasons, the most expensive item was labor (Tables 3 and 4): BRL$ 173.56 and 170.56 (US$ 57.28 and 56.29[i]), for 614.4 m^2, respectively for the first and second growing seasons, accounting for 28.5 and 29.5% of the lettuce TOC, respectively in the first and second seasons, very close to the 26% reported by Rezende *et al*. (2005b) for lettuce grown in open field. The second largest cost was depreciation, which represented 17.9 and 15.5% in the first and second seasons, respectively.

The distribution of labor was as follows: 29% for harvesting in both growing seasons, followed by side dressing (15%) and weeding (15%). Rodrigues *et al*. (1997), in an experiment also under protected cultivation, found that the harvest consumed 76% of the labor, and that labor represented only 17% of TOC. However, when surveying costs, Rodrigues *et al*. (1997) did not include the labor required for clearing the area, seedling production and weeding. Tarsitano *et al*. (1999) reported a share of 20.5% for labor in lettuce TOC, estimated in BRL$ 390.78 (US$ 128.97[i]) for 275 m^2.

Among inputs, fertilizers were the most expensive item, representing 33.9% of the costs for inputs and 13.4% of TOC for lettuce grown as a single crop, in the first season. In the following season, fertilizers were again the most expensive input and accounted for 33.2% of the item and 13.8% of the TOC. Very close to fertilizers was the cost of liming, representing around 12% of TOC, in both seasons. Nevertheless, the high liming cost can be significantly reduced by using lime with low CCE, such as calcite. If this was the case, we estimate that the liming cost in the present greenhouse (614.4 m^2) would have been BRL$ 5.00 (US$ 1.65[i]), as low as 1% of the TOC.

The TOC for tomato as single crop were BRL$ 2,060.31 and 1,908.92 (US$ 679.97 and 630.00[i]) respectively for the first and second growing seasons, in a 614.4 m^2 greenhouse (Tables 3 and 4). The difference between growing seasons was due to the more intensive use of pesticides and irrigation in the first season. Without considering possible optimizations in labor and machine hours, among many other components of the production cost, and assuming a direct correlation between costs in 614.4 m^2 and its estimate in 10,000 m^2, the TOC of tomato in single cropping amounted to approximately BRL$ 32,301.68 (US$ 10,660.62[i]) ha^{-1} (average for the two seasons).

Labor was the heaviest component in tomato TOC in both growing seasons, almost all due to non specialized labor. In the first and second growing seasons, the total cost for labor, respectively BRL$ 531.83 and 503.03 (US$ 175.52 and 166.02[i]) in 614.4 m^2, accounted for 25.8 and 26.4% of tomato TOC. According to Anuário (2005), the cost of labor for growing table tomatoes in a protected environment is BRL$ 1,951.00 (US$ 643.89[i]) 350 m^{-2}, which corresponds to 31% of the estimated production cost. Pesticides were the second largest expense and represented 22.0 and 20.8% of the total costs respectively in the first and second seasons. Although tomato is well known as a high nutrient demanding crop, fertilizers amounted to not roughly 11% of the total costs, including liming. Instead, Anuário (2005) reports that the shares for fertilizers and pesticides correspond respectively to 20.6 and 12.7% of the tomato production cost.

Greenhouse depreciation was an important item in the composition of tomato TOC as a single crop, accounting for approximately 14.5% of the TOC in both seasons. The lowest figures for greenhouse depreciation observed for lettuce are due to the higher number of cycles that are possible to carry out with lettuce in comparison to tomato in the same period of time, estimated here as ten years.

TOC for intercropping in the first and second growing seasons were, respectively, BRL$ 2,277.46 and 2,117.11 (US$ 751.64 and 698.72[i]), in 614.40 m^2, under protected cultivation (Tables 3 and 4). As observed for lettuce and tomato in single cropping, labor was the main component of TOC also in intercropping, corresponding to 28.0 and 28.8% respectively in the first and second seasons. Rezende *et al*. (2005a) reported that labor corresponded to 20.6% of the TOC and was also its heaviest component. Nevertheless, while labor, specialized or not, required 293.34 hours in single cropping, the demand fell to 265.39 hours in intercropping. The economy of 27.95 hours happened because there were common operations for both crops. When land clearing, plowing, seedbed raising, side dressing, hand hoeing and irrigation were carried out to one crop, they were automatically being carried

Table 3. Technical coefficients and total operational costs to grow tomato and lettuce in single and intercropping, under protected cultivation from April to September, 2003 (coeficientes técnicos e custo operacional total para o cultivo solteiro e em consórcio de tomate e alface, em ambiente protegido, no período de abril a setembro de 2003). Jaboticabal, UNESP, 2009.

Agricultural practices[1]	Tomato			Lettuce			Tomato x lettuce		
	Labor in common	Tractor driver	Machine + implement[3]	Labor in common	Tractor driver	Machine + implement[3]	Labor in common	Tractor driver	Machine + implement[3]
	Hours for a 614.4 m^2 greenhouse								
Production of seedlings	1.12	-	-	3.08	-	-	4.20	-	-
Land clearing	0.30	-	0.30	0.30	-	0.30	0.30	-	0.30
Plowing	-	0.25	0.25	-	0.25	0.25	-	0.25	0.25
Seedbed raising	-	0.85	0.85	-	0.85	0.85	-	0.85	0.85
Liming and fertilizing	2.15	-	-	2.15	-	-	2.15	-	-
Planting site plotting	1.34	-	-	5.38	-	-	6.72	-	-
Transplant	1.20	-	-	4.60	-	-	5.80	-	-
Hand hoeing	12.60	-	-	10.50	-	-	12.60	-	-
Sidedressing	11.52	-	-	10.62	-	-	22.14	-	-
Pesticide spraying	64.75	-	64.75	7.40	-	7.40	64.75	-	64.75
Irrigation	19.00	-	76.00	6.50	-	26.00	19.00	-	76.00
Placing of plastic ribbons	12.53	-	-	-	-	-	12.53	-	-
Staking/sprout thinning	34.30	-	-	-		-	34.30	-	-
Top pruning	7.00	-	-	-	-	-	7.00	-	-
Harvest and post harvest	52.40	-	28.00	20.40	-	5.40	72.80	-	33.40
Total (hours)	**220.21**	**1.10**	**170.15**	**70.93**	**1.10**	**40.20**	**264.29**	**1.10**	**175.55**
Total cost (BRL$ 614.4 m^{-2})[1,2]	**528.50**	**3.33**	**68.90**	**170.23**	**3.33**	**33.37**	**634.30**	**3.33**	**73.55**
Inputs	Amount	BRL$ 614.4 m^{-2} [1,2]		Amount	BRL$[1] 614.4 m^{-2} [1,2]		Amount	BRL$[1] 614.4 m^{-2} [1,2]	
Lime (kg)	70.00	70.00		70.00	70.00		70.00	70.00	
Single superphosphate (kg)	58.50	26.91		38.89	17.89		58.50	26.91	
Potassium chloride (kg)	30.00	33.00		5.95	6.55		30.00	33.00	
Ammonium nitrate (kg)	64.50	87.08		41.10	55.49		101.36	136.84	
Substrate (kg)	25.00	10.00		25.00	10.00		50.00	20.00	
Herbicide (L)	0.50	7.68		0.50	7.68		0.50	7.68	
Seeds (g)	6.05	137.58		5.09	2.04		-	139.61	
Surfactant (L)	1.64	24.53		0.22	3.23		1.64	24.53	
Pesticides	-	429.03		-	63.10		-	429.03	
Smooth wire nº 14 (kg)	13.00	64.22		-	-		13.00	64.22	
Plastic ribbons (kg)	22.50	168.30		-	-		22.50	168.30	
Costs	BRL$ 614.4 m^{-2} [1,2]								
Inputs		1,058.33			235.97			1,120.12	
Operational		1,659.07			442.90			1,831.30	
Depreciation (greenhouse)		311.60			106.60			311.60	
Depreciation (others)		89.64			47.06			134.56	
Total operational cost		**2,060.31**			**596.56**			**2,277.46**	

[1]US$ 1.00 = BRL$ 3.03, May, 2005 (US$ 1,00 = R$ 3.03, maio de 2005); [2]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)); [3]Cost includes fuel, maintenance, repairs, garage, and insurance (os custos incluem combustível, manutenção, reparos, garagem e seguro).

Table 4. Technical coefficients and total operational costs to grow tomato and lettuce in single and intercropping, under protected cultivation from January to June, 2004 (coeficientes técnicos e custo operacional total para o cultivo solteiro e em consórcio de tomate e alface, em ambiente protegido, no período de janeiro a junho de 2003). Jaboticabal, UNESP, 2009.

Agricultural practices[1]	**Tomato**			**Lettuce**			**Tomato x lettuce**		
	Labor in common	**Tractor driver**	**Machine + implement[3]**	**Labor in common**	**Tractor driver**	**Machine + implement[3]**	**Labor in common**	**Tractor driver**	**Machine + implement[3]**
	Hours for a 614.4 m^2 greenhouse								
Production of seedlings	1.12	-	-	3.08	-	-	4.20	-	-
Land clearing	0.30	-	0.30	0.30	-	0.30	0.30	-	0.30
Plowing	-	0.25	0.25	-	0.25	0.25	-	0.25	0.25
Seedbed raising	-	0.85	0.85	-	0.85	0.85	-	0.85	0.85
Liming and fertilizing	2.15	-	-	2.15	-	-	2.15	-	-
Planting site plotting	1.34	-	-	5.38	-	-	6.72	-	-
Transplant	1.20	-	-	4.60	-	-	5.80	-	-
Hand hoeing	12.60	-	-	10.50	-	-	12.60	-	-
Sidedressing	11.52	-	-	10.62	-	-	22.14	-	-
Pesticide spraying	55.50	-	55.50	7.40	-	7.40	55.50	-	55.50
Irrigation	16.25	-	65.00	5.25	-	21.00	16.25	-	65.00
Placing of plastic ribbons	12.53	-	-	-	-	-	12.53	-	-
Staking/sprout thinning	34.30	-	-	-		-	34.30	-	-
Top pruning	7.00	-	-	-	-	-	7.00	-	-
Harvest and post harvest	52.40	-	28.00	20.40	-	5.40	72.80	-	33.40
Total (hours)	**208.21**	**1.10**	**149.90**	**69.68**	**1.10**	**35.20**	**252.29**	**1.10**	**155.30**
Total cost (BRL$ 614.4 m^{-2})[1,2]	**499.70**	**3.33**	**64.28 [5]**	**167.23**	**3.33**	**32.37**	**605.50**	**3.33**	**68.70**

Inputs	**Amount**	**BRL$ 614.4 m^{-2} [1,2]**	**Amount**	**BRL$[1] 614.4 m^{-2} [1,2]**	**Amount**	**BRL$[1] 614.4 m^{-2} [1,2]**
Lime (kg)	70.00	70.00	70.00	70.00	70.00	70.00
Single superphosphate (kg)	58.50	27.50	38.89	18.28	58.50	27.50
Potassium chloride (kg)	30.00	31.80	5.95	6.31	30.00	31.80
Ammonium nitrate (kg)	64.50	83.85	41.10	53.43	101.36	131.77
Substrate (kg)	25.00	10.25	25.00	10.25	50.00	20.50
Herbicide (l)	0.50	7.83	0.50	7.83	0.50	7.83
Seeds (g)	6.05	140.24	5.09	2.04	-	142.28
Surfactante (l)	1.40	14.22	0.22	2.19	1.40	14.22
Pesticides	-	382.52	-	64.60	-	382.52
Smooth wire nº 14 (kg)	13.00	64.22	-	-	13.00	64.22
Plastic ribbons (kg)	22.50	155.48	-		22.50	155.48

Costs	**BRL$ 614.4 m^{-2} [1,2]**		
Inputs	987.90	234.92	1,048.10
Operational	1,555.21	437.86	1,725.64
Depreciation (greenhouse)	271.70	87.78	271.70
Depreciation (others)	82.01	41.35	119.77
Total operational cost	**1,908.92**	**566.99**	**2,117.11**

[1]US$ 1.00 = BRL$ 3.03, May, 2005 (US$ 1,00 = R$ 3.03, maio de 2005); [2]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)); [3]Cost includes fuel, maintenance, repairs, garage, and insurance (os custos incluem combustível, manutenção, reparos, garagem e seguro).

Table 5. Yield and coefficients of economic efficiency for tomato and lettuce grown in single and intercropping, transplanting lettuce after tomato (produtividade e indicadores de eficiência econômica do cultivo de tomate e alface em monocultura e consórcio, com transplante de alface após tomate). Jaboticabal, UNESP, 2009.

Cropping systems	Yield (t 614.4 m^{-2})		Gross income	Total operational cost	Operational profit	RR[1]	PI[2] (%)	AUE[3]
	Tomato	Lettuce	BRL$ 614.4 m^{-2} [5,6] x 1,000					
First growing season								
Intercropping								
T + L 0 DAT-T[4]	12.7	1.1	14.7	2.3	12.4	6.4	84	1.85
T + L 10 DAT-T	12.4	1.2	14.6	2.3	12.3	6.4	84	1.85
T + L 20 DAT-T	11.8	1.0	13.7	2.3	11.4	6.0	83	1.63
T + L 30 DAT-T	12.6	0.6	12.9	2.3	10.7	5.7	82	1.36
Monocultures								
Tomato	12.5	-	12.9	2.1	10.8	6.2	84	-
Lettuce 0 DATT	-	1.2	1.9	0.6	1.3	3.2	69	-
Lettuce 10 DATT	-	1.4	2.1	0.6	1.5	3.5	72	-
Lettuce 20 DATT	-	1.4	2.2	0.6	1.6	3.6	72	-
Lettuce 30 DATT	-	1.6	2.0	0.6	1.4	3.4	70	-
Second growing season								
Intercropping								
T + L 0 DAT-T[4]	8.5	0.6	9.9	2.1	7.8	4.7	79	1.44
T + L 10 DAT-T	8.1	0.2	9.0	2.1	6.9	4.3	77	1.17
T + L 20 DAT-T	8.2	0.2	8.8	2.1	6.7	4.2	76	1.13
T + L 30 DAT-T	8.9	0.2	9.6	2.1	7.5	4.5	78	1.24
Monocultures								
Tomato	9.0	-	9.7	1.9	7.8	5.1	80	-
Lettuce 0 DATT	-	1.2	1.5	0.6	0.9	2.6	62	-
Lettuce 10 DATT	-	0.9	1.1	0.6	0.5	1.9	48	-
Lettuce 20 DATT	-	0.8	1.0	0.6	0.4	1.7	42	-
Lettuce 30 DATT	-	0.7	0.9	0.6	0.3	1.6	37	-

[1]RR= return rate (taxa de retorno); [2]PI= profitability index (índice de lucratividade); [3]AUE= area use efficiency (uso eficiente da área); [4]T + L 0 DAT-T= tomato + lettuce transplanted 0 days after tomato (tomate + alface transplantado 0 dias após tomate); [5]US$ 1.00 = BRL$ 3.03, May, 2005 (US$ 1,00 = R$ 3.03, maio de 2005); [6]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)).

out also for the other. Pesticide spraying may also be considered a common practice for tomato and lettuce, as in the early stages of both crops there is a mutual need to control Tospovirus vectors, which cause the spotted wilt. Labor optimization is one of the major advantages of intercropping over single cropping (Puiatti *et al*., 2000), once it improves profitability. Camargo Filho & Mazzei (1992) state that effective measures to improve the profitability of the rural activity are the control of production costs, keeping them as low as possible, and crop diversification. Thus, intercropping adapts perfectly well to such perspective, since it minimizes costs by the optimization of production inputs and the increase of food production per area. In addition, intercropping is, by definition, a crop diversification program.

TOC for intercropping was 14.3% lower than the sum of the costs of the two crops when grown as single crops in the first season. This percentage meant savings of BRL$ 379.41 (US$ 125.22[i]) in 614.4 m^2. In the second season, TOC for intercropping was 14.5% lower (savings of BRL$ 358.80, US$ 118.42[i], in 614.4 m^2) than the sum of costs for the two single crops. Nevertheless, it must be stressed that the savings due to intercropping go far beyond the monetary aspect. In intercropping, the use of water, fertilizers and other inputs is optimized (Horwith, 1985), with consequent reduction in the environmental impact of vegetable growing. In addition, intercropping concurs to a more efficient use of the area in small farms and greenhouses, reminding that the latter are high cost structures both for acquisition and construction, as well as for maintenance.

In the first growing season, the gross income (GI) of intercropping was always higher than those from single cropping (Table 5), even when the lettuce production was not considered (intercropping established 30 DAT) due to plant stunting and the consequent unfeasibility for commercialization. In

Table 6. Yield and coefficients of economic efficiency for tomato and lettuce grown in single and intercropping, transplanting tomato after lettuce (produtividade e indicadores de eficiência econômica do cultivo de tomate e alface em monocultura e consórcio, com transplante de tomate após alface). Jaboticabal, UNESP, 2009.

Cropping systems	Yield (t 614.4 m^{-2})		Gross income	Total operating costs	Operating profit	RR[1]	PI[2] (%)	AUE[3]
	Tomato	Lettuce	(R$ 614.4 m^{-2}) x 1,000					
First season								
Intercropping								
L + T 0 DAT-L[4]	13.1	1.6	15.8	2.3	13.5	6.9	86	2.07
L + T 10 DAT-L	12.7	1.7	15.6	2.3	13.3	6.8	85	2.12
L + T 20 DAT-L	12.7	1.5	15.4	2.3	13.1	6.8	85	1.99
L + T 30 DAT-L	12.7	1.6	15.5	2.3	13.3	6.8	85	2.07
Single Cropping								
Lettuce	-	1.5	2.4	0.6	1.8	3.9	75	-
Tomato 0 DAT-L	13.1	-	13.4	2.1	11.3	6.4	84	-
Tomato 10 DAT-L	12.8	-	13.1	2.1	11.0	6.2	84	-
Tomato 20 DAT-L	12.8	-	13.1	2.1	11.0	6.2	84	-
Tomato 30 DAT-L	12.7	-	13.0	2.1	10.9	6.2	84	-
Second season								
Intercropping								
L + T 0 DAT-L[4]	8.4	0.9	10.1	2.1	8.0	4.8	79	1.81
L + T 10 DAT-L	7.6	0.9	9.3	2.1	7.1	4.4	77	1.76
L + T 20 DAT-L	7.7	1.1	9.6	2.1	7.5	4.6	78	1.90
L + T 30 DAT-L	8.4	1.1	10.4	2.1	8.3	4.9	80	1.93
Single Cropping								
Lettuce	-	1.2	1.4	0.6	0.9	2.3	64	-
Tomato 0 DAT-L	7,9	-	8.5	1.9	6.6	4.5	78	-
Tomato 10 DAT-L	7.5	-	8.1	1.9	6.2	4.3	77	-
Tomato 20 DAT-L	7.9	-	8.5	1.9	6.6	4.5	78	-
Tomato 30 DAT-L	8.3	-	9.0	1.9	7.1	4.7	79	-

[1]RR= return rate (taxa de retorno); [2]PI= profitability index (índice de lucratividade); [3]AUE= area use efficiency (uso eficiente da área); [4]L + T 0 DAT-L= lettuce + tomato transplanted 0 days after lettuce (alface + tomate transplantado 0 dias após alface); [5]US$ 1.00 = BRL$ 3.03, May, 2005 (US$ 1,00 = R$ 3.03, maio de 2005); [6]Prices corrected using the General Price Index (IGP) (preços corrigidos utilizando o Índice Geral de Preços (IGP)).

this particular case, tomato yield exceeded that obtained in single cropping. As the intercropping systems progressed, with lettuce being transplanted each turn later, GI decreased. This economic pattern closely resembles that observed with the index of Area Use Efficiency (AUE) (Table 5) and reflects the negative effect of tomato over lettuce, as lettuce transplant was delayed.

The values for GI regarding the monocultures of tomato and lettuce, namely BRL$ 14.801,58 and 1.228,80 (US$ 4,885.00 and 405.54[i]) m^{-2} respectively, in a 614.4 m^2, were merely 0.7% higher than the intercropping GI, when crops were transplanted at the same day. The operating profits (OP) of the intercropping, when a crop was transplanted 0, 10 and 20 days after the other, proved to be higher than those obtained in monoculture (Table 5). Intercropping OP, when both crops were transplanted on the same day, was 14.5% higher than OP observed for tomato grown as a single crop in the same area. In addition, intercropping OP exceeded in 1.6% the sum of the OP from tomato and lettuce grown as single crops in two greenhouses. Only the intercropping started 30 DAT tomato did not show OP higher than tomato as monoculture. In this date, the shrinking of lettuce yield and the impossibility of commercialization, due to stunting, were responsible for the economic failure. In this case, OP has not confirmed the productive advantage of intercropping pointed out by the index of area use efficiency, which scored 1.36 (Table 5). This is a clear example of the need to carry out economic analysis for intercropping, as proposed by Zanatta *et al.* (1993), in order to better judge the results obtained out of different cropping systems.

The values observed for OP showed that the labor reduction in intercropping, although small and with a modest impact on TOC, was enough to make intercropping economically viable in comparison to the single crops. Considering a single 614.4 m^2 greenhouse and intercropping lettuce and tomato by transplanting both at the same day, the farmer profitability increased in BRL$ 1,582.20 (US$ 522.18[i]) in each crop.

In the second growing season (Table 5), the results for GI and OP differed to a great extent from those observed in the first season. In the second season, only the intercropping established by transplanting both crops at the same date had higher GI than tomato as single crop. Moreover, OP for all intercropping schedules (0, 10, 20 or 30 DAT tomato) was lower than those of the monoculture of tomato. Conversely, in the first season, GI and OP for all intercropping designs exceeded those from monoculture, except for the intercropping started 30 DAT tomato. In the second season, results were heavily impacted by the general yield reduction observed in lettuce, which was as strong as 50% when compared to lettuce in monoculture, when lettuce and tomato were transplanted on the same day. The lettuce harvested out of intercropping established 20 and 30 DAT tomato had no commercial value and thus did not provide any economic contribution to the intercropping system.

In general terms, the economic assessments corroborated the efficiency in using the greenhouse as expressed by the area use efficiency index (AUE) in each intercropping schedule, in both seasons. Return rates (RR) in intercropping had a similar behavior to OP. In the first and second season, RR in intercropping, regardless of the intercropping schedule, was higher than RR for tomato as single crop (Table 5). In the first season, while in tomato as single crop, the farmer received BRL$ 6.25 (US$ 2.06[i]) for each BRL$ 1.00 invested, in the intercropping set 0 and 10 DAT tomato, the return was 10 and 9% higher respectively, than the average obtained in single crops. RR in intercropping can be higher if the cultivated area is expanded, since the capital needed to start and sustain the activity is not directly proportional to the increase in the cultivated area, due to the optimization of available inputs, equipment and labor. Higher RR and shorter time to recover the investment were simulated by Rodrigues *et al*. (1997) and Tarsitano *et al*. (1999) as lettuce production were scaled up from two to four and eight 350 m^2 greenhouses.

RR for tomato as single crop corresponded to almost twice the RR for the most profitable lettuce monocultures, in both seasons. RR were lower in the second than in the first season independent of the crop system, pressed by the drop in the tomato and lettuce yields due to respectively the tomato leafminer (*Tuta absoluta*) and heat. RR is directly related to the valuation of the crop product. Any factor that lowers either quantity or quality with negative reflects on prices, will bring RR down. Rezende *et al*. (2005c) observed reduction in lettuce RR both as single crop and intercropped with radish as function of the increase in lettuce density, which resulted in lighter plants and less yield, thus, lower GI.

There were no differences regarding the profitability index (PI) between the intercropping set 0 and 10 DAT tomato and tomato in monoculture (Table 5). On the other hand, PI indicated a turnover similarity between the intercropping established 0 and 30 DAT tomato, which may mislead farmers in the choice of the best intercropping schedule. PI showed that the two schedules gave farmers similar returns in relation to the investment. However, revenues may be very distinct between the two situations, as in fact it happened. Thus, PI did not reflect adequately the best intercropping performance, as indicated by AUE, GI, OP and RR for the intercropping set 0 and 10 DAT tomato, especially in the first growing season. Once PI is calculated by the ratio between net and gross income, the figures for the intercropping established 20 and 30 DAT tomato, in the second season, were very close to those observed for the intercropping set 0 and 10 DAT, also in the second season, even when in the first two schedules (20 and 30 DAT), there were severe drops in both lettuce yield and quality, which prevented commercialization and therefore, resulted in no lettuce contribution to incomes.

Results were more promising in intercropping schedules where tomato was transplanted after lettuce than in the other way around. GI was higher when tomato was transplanted after lettuce in the first season (Table 6) than in the other three studied situations, namely the transplant of lettuce after tomato in both growing seasons (Table 5) and transplant of tomato after lettuce in the second growing season (Table 6). These results reflect the high yields achieved by tomato and lettuce in the experiments. The high figures we observed for AUE, as well as for returns, came very likely from the good complementarity between lettuce and tomato, as depicted by the lack of depressive effects on yield from one species over the other.

The highest OP, BRL$ 13,485.41 (US$ 4,450.63[i]) in 614.4 m^2, was obtained in the first season, in intercropping, by transplanting tomato and lettuce in the same day. It went far beyond the figure from the monoculture of tomato, BRL$ 2,222.47 (US$ 733.50[i]) in the same acreage. The result is a clear consequence of the integration on the use of labor, machinery and implements and also of other inputs in intercropping, without depressing yield. The economic advantage of intercropping is noticeable also by other parameters. The figure for the intercropping TOC is lower than the sum of TOC of both monocultures. The same intercropping schedule, tomato and lettuce transplanted at the same day, produced, in 614.4 m^2 of protected environment, an OP BRL$ 466.57 (US$ 153.98) higher than the sum of OP for the monocultures of tomato and lettuce in 1,228.8 m^2, equivalent to two greenhouses. Similarly, the intercropping established 10, 20 and 30 DAT also achieved, in 614.4 m^2, OP higher than the sum of monocultures, in 1,228.8 m^2 (Table 6).

The intercropping in the second growing season, as it was in the first season, had higher economic viability than the monoculture, if one considers GI and OP. OP for intercropping, in 614.4 m^2, exceeded the sum of OP of monocultures, in 1,228.8 m^2 (Table 6). Cecilio Filho & May (2002), in the evaluation of lettuce intercropped with radish, also found high complementarity between the two vegetables, especially when radish was sown up to 7 DAT lettuce. These authors noted that in this situation, intercropping had a GI 48% higher than lettuce as a single crop. Brown *et al*. (1985) found that cabbage and tomato in intercropping had net incomes very close to the monocultures.

RR in the monoculture of tomato was higher than in lettuce in both growing seasons (Table 6), with a range similar to what was observed in intercropping whenever lettuce was transplanted after tomato (Table 5). RR in intercropping, regardless of the intercropping schedule, was approximately 8,8% higher than in monoculture, in the first season. In the second season, RR in intercropping and in tomato as single crop were very alike, with a slight superiority for intercropping, 3.9% in average.

As also observed for the intercropping schedules where lettuce was transplanted after tomato, PI for those schedules where tomato was transplanted after lettuce were very similar to each other. Tomato PI was also higher than lettuce's. In principle, one could have assumed that PI for intercropping would lie somewhere in between PI of lettuce and tomato as single crops. However, we observed a close correspondence between PI of intercropping and tomato, which is explained by the major contribution of tomato to costs and revenues in comparison to lettuce, and also by the relative reduction in the production cost per acreage.

Based on the economic indexes, tomato was the most interesting crop for farmers in both periods. Brown *et al*. (1985), upon evaluating the intercropping of tomato and cabbage and also of collard greens and melon, concluded that, despite the high production cost, the economic return provided by tomato justifies its use in intercropping, especially in small acreages. The economic indexes have ratified the feasibility of production, expressed by the AUE index, for the following intercropping schedules: tomato and lettuce transplanted in the same day, in both seasons; lettuce transplanted 10 and 20 DAT tomato, in the first season; and all schedules where tomato was transplanted after lettuce.

Considering our results, we could conclude that: a) the growing season influenced the interaction between the species used in the intercropping and therefore the economic viability and superiority of intercropping over monoculture; b) the economic indexes were higher for intercropping and monoculture in the first than in the second growing season; c) the delay in transplanting lettuce in relation to tomato was crucial for the economic superiority of intercropping over monoculture; d) whenever tomato was transplanted after lettuce, the intercropping exceeded the tomato monoculture, in economic terms; and e) intercropping allowed for the optimization in the use inputs and labor, with consequent reduction in operating cost per unit of area.

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