Ciência Agrícola, Rio Largo, v. 19, n. 3, p. 203-210, 2021

ARROWROOT INTERCROPPED WITH GREEN CORN, AGROECONOMICALLY VIABLE

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ABSTRACT: Arrowroot is a long cycle vegetable with low nutritional requirements and potential for intercropping with species with shorter cultural cycle, which can provide the farmer with complementary and anticipated income during arrowroot cultivation. The objective was to verify the agroeconomic viability of intercropping arrowroot with green corn in four association times. The experiment consisted of nine treatments involving arrowroot intercropping with corn in four association times after the emergence of arrowroot plants (DAE = 0, 30, 60 and 90), in addition to their respective monocultures. The experimental design was a randomized block design, with five replicates. Crop yield data, arrowroot starch content and agroeconomic efficiency indicators were evaluated. Results were submitted to analysis of variance, means were compared by the Tukey's test, and contrasts (F test) were performed between monocrops and intercropping for variables measured in the green corn crop. It could be concluded that intercropping arrowroot with green corn is agronomically and economically viable. In economic terms, the association of green corn with arrowroot should preferably be installed at 60 DAE of arrowroot emergence.

KEYWORDS: association of cultures; *Maranta arundinaceae*; economic indicators; productivity; starch.

CONSÓRCIO ARARUTA COM MILHO VERDE, APRAZÍVEL AGROECONOMICAMENTE

RESUMO: Araruta, hortaliça de ciclo longo, de baixa exigência nutricional e com potencial para a consorciação com espécies de menor ciclo cultural, o que pode proporcionar ao agricultor renda complementar e antecipada durante o cultivo da araruta. O objetivo foi verificar a viabilidade agroeconômica do consórcio da araruta com milho verde em quatro épocas de associação. O experimento foi constituído de nove tratamentos envolvendo os consórcios da araruta com milho, em quatro épocas da associação após a emergência das plantas de araruta (DAE = 0, 30, 60 e 90), além de suas respectivas monoculturas. O delineamento experimental foi o de blocos casualizados, com cinco repetições. Avaliaram-se dados produtivos das culturas, teor de amido da araruta e indicadores agroeconômicos de eficiência. Os resultados foram submetidos à análise de variância, as médias de comparadas pelo teste de Tukey, e realizados contrastes (teste F) entre monocultivos solteiros e consórcios para as variáveis medidas no milho verde. Concluiu-se que é viável, agronômica e economicamente, a consorciação da araruta com milho verde. Em termos econômicos, a associação do milho verde com araruta deve ser instalada, preferencialmente, aos 60 DAE das plantas de araruta.

PALAVRAS CHAVE: associação de culturas; *Maranta arundinaceae*; indicadores econômicos; produtividade; amido.

INTRODUCTION

Arrowroot, *Maranta arundinaceaea* L., originally from South America, is considered an unconventional and rhizomatous vegetable. It grows forming clumps that reach 1.2 m in height, being used to extract excellent quality starch, whose fresh rhizome content varies from 18 to 23%, depending on the plant age (Kinupp and Lorenzi, 2014).

Starch is the main source of energy of higher plants and is widely used mainly in the food, textile, chemical and pharmaceutical industries, where it has intensified every year, the food sector being the largest consumer due to the use of starch for the elaboration of foods. Studies on new sources of starch and better extraction techniques have been carried out, since the starch characteristics depend on its botanical origin (Abegunde et al., 2013).

The main sources of commercial starch are corn, wheat, potato and cassava. However, arrowroot starch has unique characteristics and qualities, which confer lightness and high digestibility, being used as ingredient or additive in low amounts to improve product presentation or conservation. Due to the ability to form gel and absence of gluten, this starch has been indicated as alternative for the production of breads, cookies and cakes (Cunha, 2016) aimed mainly at celiac individuals.

With the need for alternative sources of starch, arrowroot has gained space in the market and boosted the interest of farmers in its cultivation, especially in family farming, due to its high market value, in addition to its low requirement for sophisticated technologies, being therefore suitable for family farming (Vieira et al., 2015).

One of the major obstacles for arrowroot cultivation is its long cultural cycle, which can vary from 9 to 14 months, a fact that makes cultivation difficult, especially in family farming, where physical land area is a limiting factor. Thus, characteristics of low nutritional requirement, combined with those of the long cultural cycle, open the perspective of the potential cultivation of arrowroot intercropped with species with shorter cultural cycle, providing the farmer with complementary and anticipated income during arrowroot cultivation.

Based on the above, the aim of this work was to verify the agroeconomic viability of arrowroot intercropped with green corn in four association times.

MATERIAL AND METHODS

The experiment was conducted in the field from 10/20/2015 to 09/06/2016 in the vegetable garden of the Department of Plant Science - Federal University of Viçosa (UFV). The municipality of Viçosa has altitude of 650 m a.s.l, south latitude of 20° 45’, west longitude of 42° 51’ and high-altitude tropical climate, with rains in the summer and drought in the winter. The average temperature during the experimental period was 20.4 °C; with average minimum temperature of 14.3 °C; average maximum temperature of 26.2 °C; and total precipitation of 1132.22 mm.

The soil of the cultivation area is characterized as Cambic Red-Yellow Argisol, loamy-sandy loam texture (Embrapa, 2013), whose sampling was carried out in the 0-20 cm layer, indicating the following results: pH(water) = 5.7; P = 42.3 and K = 69 mg dm^{-3}; Ca^{2+} = 1.8; Mg^{2+} = 0.4 and Al^{3+} = 0.0 cmolc dm^{-3}; B = 0.3; Fe = 75.4; Mn = 122.8; Zn = 14.5 and Cu = 4.2 mg dm^{-3}; OM = 1.97 dag kg^{-1}; (H + Al) = 3.77; BS = 2.38; CEC (t) = 2.38 and CEC (T) = 5.85 cmolc dm^{-3} ; V = 41% and P-rem = 36.7 mg l^{-1}.

The experiment consisted of nine treatments, consisting of four times of arrowroot (main crop) intercropped with corn, and their respective single crops (Table 1). The experiment was conducted in a randomized block design, with five replicates.

Table 1. Treatments used and dates of implementation of arrowroot crops, single and intercropped, in each planting season.

Treat.	Description of treatments	Arrowroot Planting date	Green corn Planting date	(DAE)*
1	Arrowroot Single	10/20/2015	-	-
2	Arrowroot + Green corn	10/20/2015	11/23/2015	0
3	Arrowroot + Green corn	10/20/2015	12/22/2015	30
4	Arrowroot + Green corn	10/20/2015	01/21/2016	60
5	Arrowroot + Green corn	10/20/2015	02/22/2016	90
6	Green corn Single	-	11/23/2015	0
7	Green corn Single	-	12/22/2015	30
8	Green corn Single	-	01/21/2016	60
9	Green corn Single	-	02/22/2016	90

*DAE = Days after arrowroot emergence

Arrowroot rhizomes of the 'Viçosa' variety, from the UFV Vegetable Germplasm Bank, with average mass of 10.0 g and 16 cm in length, were used as seedlings. The green corn seeds used were of the 'AL Bandeirante' variety (Cati, 2018), intended for family farming.

Arrowroot was planted in furrows 0.80 m apart, opened to a depth of 0.12 m, where seedlings (rhizomes) were placed every 0.25 m and covered with soil. Corn was sown at four pre-established times, that is, at 0, 30, 60 and 90 days after the emergence of arrowroot plants (DAE).

Green corn plants were distributed in the same row as arrowroot plants and, in both single and intercropping, spaced 0.80 m between rows and, individually, every 0.25 m in the row. Seeds were placed in pits at 0.05 m in depth and, in the intercropping, opened between arrowroot plants, and covered with soil. Three green corn seeds were sown per pit, and thinning was carried out 15 days after sowing, leaving only one plant every 0.25 m. Thus, single crops or in association had the same populations (additive association), that is, 50,000 plants ha^{-1} of arrowroot and/or green corn plants.

The experimental plot consisted of four rows spaced 0.80 m and 2.5 m in length, containing ten plants per row, totaling 40 arrowroot and/or green corn plants, in a total area of 8 m^2 per plot. The area occupied by 12 arrowroot and/or green corn plants in the two central rows of the plot was considered as useful area in evaluations.

Soil fertilization was carried out for each crop based on soil chemical and physical analysis and recommendation for corn cultivation and due to the lack of recommendation for arrowroot cultivation and because they present similar physiological development characteristics, recommendation for yam cultivation (taro) for the State of Minas Gerais was used.

Weed control was mechanically performed using a hoe. In the absence of rainfall and up to 30 days before arrowroot harvest, crops were weekly irrigated by sprinkling, applying, on average, in each irrigation, water depth of about 30 mm per irrigation, sufficient to meet crop demands.

Green corn cobs were harvested when grains were in the milky phase (creamy stage), for the four planting seasons, reached, on average, 100 days after planting. Thus, diameter at breast height (DAPE), cob length with (CECP) and without straw (CESP), cob diameter with (DECP) and without straw (DESP), cob fresh mass with (MECP) and without straw (MESP) and total yields, referring to cob mass with straw (PTC), and commercial yield, referring to the total cob mass without straw (PTS), both measured in $t.ha^{-1}$ were measured. After harvesting green cobs, corn plants were mown close to the soil and arranged laterally in the arrowroot row.

Arrowroot was harvested at 318 DAP, when 50% of plants were in a state of shoot senescence. Twelve plants were collected from the useful rows of each experimental unit. After removing shoots, rhizomes were classified according to Heredia Zárate et al. (2005) into three classes: large (> 20 cm), medium (12 to 20 cm) and small (< 12 cm). The rhizomes of each class were counted and weighed, and their yield (t ha^{-1}) was calculated. Starch production was estimated according to method described by Vieira et al. (2015).

The agroeconomic indicators used to evaluate the efficiency of intercropped systems were: Efficient Land Use Index (UET), gross income (RB), net income (RL), monetary advantage (VM) and corrected monetary advantage (VMc). The UET index was calculated according to Willey (1979), obtained by the expression: UET = (Yab/Yaa) + (Yba/Ybb), where: Yab is the commercial yield of crop "a" intercropped with crop "b"; Yaa is the commercial yield of crop "a" in monoculture; Yba is the commercial yield of crop "b" intercropped with crop "a"; and Ybb is the commercial yield of crop "b" in monoculture.

Gross income (RB) was calculated by multiplying the commercial yield of the crop/ha in each treatment by the price of the product paid to producers at CEASA-MG, at each harvest time. For arrowroot, the price of the product on the day of harvest was R$ 7.00/kg of rhizomes (Emater, 2016) and, for corn, R$ 0,79; R$ 0,63; R$ 0,95 and R$ 1,05/kg of commercial cob, in the first, second, third and fourth planting seasons, respectively (Ceasa-MG, 2016).

Operating Profit was obtained by subtracting, from gross income, production costs derived from inputs plus services. These costs were calculated for each treatment, considering the prices of inputs and services used in the arrowroot and corn crops, at experimental level, based on indicators by Gassi et al. (2014). The monetary advantage (VM) and the corrected monetary advantage (VMc) were calculated by the following expressions: VM = RB (UET - 1)/UET and VMc = RL (UET -1)/ UET, according to Beltrão et al. (1984).

Data obtained were submitted to analysis of variance. Arrowroot production means and financial ratios were compared using the Tukey's test. Contrasts (F test) were performed between single and intercropped crops for the characteristics evaluated in green corn. All tests were performed at 5% probability and analyses were performed using the SAEG 9.1 statistical software (UFV, 2007).

RESULTS AND DISCUSSION

Both the growth characteristics of green corn plants and productive ones (fresh matter mass of cobs with and without straw) of intercropped treatments did not differ from the respective single treatments in the respective association times with arrowroot (Table 2). These results suggest that green corn plants did not suffer competition from arrowroot plants for growth factors, even when the association occurred at 30, 60 or 90 DAE, and it is possible that green corn, as a fast growth species, became dominant when intercropped, not suffering any or insignificant interference from arrowroot plants.

Table 2. Mean values observed in green corn of contrasts between single and intercropped crops with arrowroot in the four association times ($\hat{Y}1$, $\hat{Y}2$, $\hat{Y}3$ and $\hat{Y}4$), for characteristics height (ALT), diameter at breast height (DBH), cob length with (CECP) and without straw (CESP), cob diameter with (DECP) and without straw (DESP), fresh matter mass of cobs with (MECP) and without straw (MESP) and total yield of cobs with (PTC) and without straw (PTS)

Contrasts	Treat.	ALT	DAP	CECP	CESP	DECP	DESP	MECP	MESP	PTC	PTS
		M	.... cm				....	.................g.................		...............tha^{-1}	....
$\hat{Y}1$	6	2.79	2.23	32.24	29.07	5.37	4.28	399.09	263.22	13.30	8.38
	2	2.83	1.98	31.97	29.33	5.24	4.12	348.65	217.44	11.62	7.41
		-0.04^{NS}	0.25^{NS}	0.27^{NS}	-0.26^{NS}	0.13^{NS}	0.16^{NS}	50.44^{NS}	45.78^{NS}	1.68^{NS}	0.97^{NS}
$\hat{Y}2$	7	2.75	1.89	33.31	30.49	5.38	4.22	418.93	292.83	13.96	8.81
	3	2.62	1.78	33.29	30.72	5.19	4.03	403.65	274.98	13.45	8.18
		0.13^{NS}	0.11^{NS}	0.02^{NS}	-0.23^{NS}	0.19^{NS}	0.19^{NS}	15.28^{NS}	17.85^{NS}	0.51^{NS}	0.63^{NS}
$\hat{Y}3$	8	2.68	1.85	31.21	28.94	5.75	4.58	426.24	277.81	14.21	8.81
	4	2.63	1.61	30.98	28.17	5.34	4.36	355.82	203.49	11.86	7.85
		0.05^{NS}	0.24^{NS}	0.23^{NS}	0.77^{NS}	0.41^{NS}	0.22^{NS}	70.42^{NS}	74.32^{NS}	2.35^{NS}	0.96^{NS}
$\hat{Y}4$	9	2.48	1.82	28.94	25.98	5.68	4.54	395.17	252.61	13.17	8.42
	5	2.41	1.68	27.83	25.03	5.39	4.32	352.82	205.42	11.76	6.84
		0.07^{NS}	0.14^{NS}	1.11^{NS}	0.95^{NS}	0.29^{NS}	0.22^{NS}	42.35^{NS}	47.19^{NS}	1.41^{NS}	1.58^{NS}

NS: not significant by the F test at 5% probability. $\hat{Y}1$ – Single green corn at 0 DAE (T6) vs. Green corn intercropped with arrowroot at 0 DAE (T2); $\hat{Y}2$ – Single green corn at 30 DAE (T7) vs. Green corn intercropped with arrowroot at 30 DAE (T3); $\hat{Y}3$ – Single green corn at 60 DAE (T8) vs. Green corn intercropped with arrowroot at 60 DAE (T4); $\hat{Y}4$ – Single green corn at 90 DAE (T9) vs. Green corn intercropped with arrowroot at 90 DAE (T5).

Brito et al. (2018) studied the productive performance of two mangarito varieties - a vegetable with physiological characteristics such as development cycle, propagation method, nutritional requirements, among others, similar to those of arrowroot - intercropped with green corn at four association times and found results similar to those of the present work, where the green corn fresh mass yield was not influenced by the presence of mangarito plants during cultivation, however, mangarito plants were affected.

Regarding green corn yield, Brito et al. (2018) found maximum yield of 9.24 t ha^{-1} of green corn cobs without straw, obtained in the single treatment against 8.35 t ha^{-1} of corn intercropped with 'Pequeno' mangarito at 0 DAE, while the worst yield of 6.46 t ha^{-1} was obtained intercropping with 'Gigante' mangarito established at 21 DAE. Therefore, the green corn production values obtained here were very close to those obtained by Brito et al. (2018), which can be evaluated as a satisfactory result when using green corn intercropped with arrowroot, considering, in addition to yields, the financial return shown by agroeconomic indicators.

The evaluation of arrowroot rhizomes allowed identifying that the fresh mass yields of large (FG) and total (FT) rhizomes of treatment with arrowroot intercropped with green corn at 60 DAE, as well as starch yield, did not it differed statistically from single arrowroot treatment, with higher values compared to the other intercrops (Table 3).

Table 3. Mean yields of fresh mass of rhizomes of large (FG), medium (FM), small (FP) and total sons (FT), starch (AM) and total number of sons (NFP) per arrowroot plant (Ar) in monoculture and intercropped with green corn (Mi), in the four association times.

Treatment	FG	FM	FP	FC	AM	NFP
		....t ha^{-1}..				un./pl
1- Ar single	9.01 ab	7.36 a	7.26 a	23.65 a	4.67 a	17.87
2-Ar + Co (0 DAE)	7.93 b	7.15 a	4.71 c	19.80 bc	3.45 b	12.80
3-Ar + Co (30 DAE)	3.86 d	7.19 a	7.16 a	18.22 c	3.19 c	13.05
4-Ar + Co (60 DAE)	9.69 a	6.74 b	6.53 b	22.97 ab	4.40 a	16.40
5-Ar + Co (90 DAE)	5.48 c	5.77 c	7.38 a	18.64 c	3.22 b	18.22
CV(%)	8.73	14.21	10.08	7.32	8.23	17.89

* Means, in columns, followed by at least one same letter, do not differ from each other by the Tukey's test, at 5% probability.

Arrowroot intercropped with green corn at 90 DAE was the treatment that presented the lowest fresh mass yields of rhizomes of large, medium and total classes, the latter not differing from intercropping at 30 DAE, which was the intercropping treatment that provided the lowest total fresh mass of rhizomes and starch (Table 3).

The lower yield of rhizomes in treatment of arrowroot intercropped with green corn at 30 DAP can be explained by the slow growth of arrowroot in the initial phase, compared to green corn, and to the rapid growth of green corn plants, promoting greater competition for growth factors (light in particular), interfering with the expression of the productive potential of arrowroot plants. Corn, being a C4 metabolism species, with high growth rate, grew quickly and caused partial light restriction to arrowroot plants, resulting in lowest averages obtained in intercropping compared to single cropping.

Results similar to these were obtained by Vieira et al. (2015), who obtained lower yield of arrowroot and starch rhizomes (12.81 and 2.07 t ha^{-1}, respectively) when intercropped crotalaria plants remained for a longer period of time.

The differences in physiological behavior in relation to the development cycles and photosynthetic mechanisms used by both cultures reinforce the hypothesis that the partitioning of photoassimilates is a function of the genotype and source-sink relationships, where the efficiency of the photosynthetic conversion, among other factors, can be altered by soil conditions, climate and crop physiological stage (Taiz and Zaiger, 2017).

Thus, according to the "principle of competitive exclusion", described by Vandermeer (1990), when two species have different requirements, they compete with each other weakly, surviving indefinitely in the same ecosystem; however, when requirements are similar, they compete strongly with each other, with one of them tending to become extinct in a given period of time.

However, even in intercropped treatments, the yields obtained with arrowroot in this study were higher than those found by Vieira et al. (2015), who also worked with 'Viçosa' arrowroot, but intercropped with crotalaria, and obtained higher yield among treatments (19.47 t ha^{-1}) in the treatment with crotalaria at 90 days after sowing.

Heredia Zárate et al. (2005) evaluated the productive performance of three different arrowroot seedlings and obtained yield of 22.92 t ha^{-1}, therefore, similar to result obtained intercropping arrowroot with green corn established at 60 DAE (22.97 t ha^{-1}), which demonstrates that intercropping arrowroot with green corn at this time is agronomically viable, since when cultivated intercropped with corn, productivity reached rates similar to those obtained in other studies that evaluated the performance of arrowroot in monoculture.

Regarding the starch content in arrowroot rhizomes, it can vary according to the cultural cycle from 18.8 to 23.8% in rhizomes harvested from plants with 12 and 14 months of cycle, respectively (Ferrari et al., 2005). In the present work, the starch content ranged from 17.54 to 19.78% and the amounts of starch produced ranged from 3.19 (intercropped with green corn at 30 DAE – worst result) to 4.67 t ha^{-1} (single arrowroot – best result), the latter not differing from arrowroot intercropped with green corn at 60 DAE (4.40 t ha^{-1}) (Table 2).

In a study by Vieira et al. (2015) with 'Viçosa' arrowroot, the starch content ranged from 16.2 to 17.8%, and the best results of mass production of rhizomes (19.17 t ha^{-1}) and starch (3.46 t ha^{-1}), were obtained in arrowroot intercropped with crotalaria at 90 DAS. Leonel and Cereda (2002) found starch content of 24.23%, with yield of 15.0 and 3.6 t ha^{-1} of rhizomes and starch, respectively. Therefore, the results obtained here for the production of arrowroot starch, especially in single cultivation and in intercropping with green corn at 60 DAE, can be considered excellent.

Table 4 shows the economic indicators of the arrowroot and green corn intercropped systems. Intercropping systems provided greater use of the land factor than the single system, since the land use indices (UET) were higher than the unit. The UET of the corn and arrowroot intercropping system ranged from 163% for the intercropping system established at 90 DAE, to 214% for that established at 60 DAE. This means that it would be necessary, respectively, 63% and 114% more, in physical area, for corn and arrowroot, in single crops, to produce the equivalent of intercropping production in one hectare.

Table 4. Land Use Index (UET), Gross Revenue (RB), Operating Profit (LO), Monetary Advantage (VM) and Corrected Monetary Advantage (VMc) for treatments single arrowroot, arrowroot intercropped with green corn and single green corn in the respective association times

Treatments	UET	RB (R$ ha^{-1})	LO (R$ ha^{-1})	VM (R$ ha^{-1})	VMc (R$ ha^{-1})
1-Ar	1.00 c	165.572.250 a	157.963.500 a	-	-
2-Ar+Co (0DAP)	1.72 b	138.648.500 b	126.958.500 b	58.220.750 b	53.322.500 b
3-Ar+ Co (30DAP)	1.85 b	127.597.250 b	115.907.250 b	58.593.750 b	53.233.001 b
4-Ar+ Co (60DAP)	2.14 a	160.807.750 a	149.117.750 a	86.145.500 a	79.913.250 a
5-Ar+ Co (90DAP)	1.63 b	130.515.250 b	118.825.250 b	50.528.750 b	46.015.250 b
6- Co (0DAP)	1.00 c	6.621.25 c	1.069.25 c	-	-
7- Co (30DAP)	1.00 c	5.555.50 c	0.0035 c	-	-
8- Co (60DAP)	1.00 c	8.362.25 c	2.810.25 c	-	-
9- Co (90DAP)	1.00 c	8.841.00 c	3.289.00 c	-	-
CV (%)	6.67	10.72	11.94	18.07	18.88

* Means, in columns, followed by at least one same letter, do not differ from each other by the Tukey's test, at 5% probability

Despite the high UET in all intercropping systems, associations established at 0, 30 and 90 DAE provided lower revenues and operating profit than single arrowroot and the association of arrowroot with green corn established at 60 DAE. High UET value indicates the best land use for food production; however, in this work, arrowroot is more valued than green corn due to the price obtained in the market. Monetary advantages (VM and VMc) followed the revenue and operating profit results, with higher values obtained in the association established at 60 DAE.

The total yield of arrowroot rhizomes intercropped with green corn established at 60 DAE was very close to that of the single crop (22.97 against 23.65 t ha^{-1}), a fact that justifies the approximate value of the operating profit of these treatments, since the return (LO) obtained with the green corn crop was relatively small (Table 4).

In the work of intercropping 'Gigante' mangarito with green corn established at 63 DAE, Brito et al., (2018) obtained yield and economic data similar to those observed in the present research, where intercropping arrowroot with green corn at 60 DAE provided greater increases in yield in relation to the other association times, without differing regarding economic indicators of arrowroot in monoculture.

In the case of intercropping, profitability can be very variable (Brito, 2017). Intercropped crops, in terms of phenology, tolerance to competition for growth factors, times of associations, arrangements and management used and, finally, the quantity and value of the harvested product, are factors that will influence the financial results.

In economic terms, despite the significant values, intercropped crops did not show such a high financial return when compared to single crops.

This was due to the satisfactory yield of arrowroot in monoculture, in addition to its high market value, whose starch, a product derived from arrowroot, has been marketed at R$ 35,00/kg, according to EMATER-MG.

Although intercropping did not provide higher revenues and operating profit compared to arrowroot in monoculture, it is worth mentioning that the harvest of corn cobs started about 100 days after sowing (130 days after arrowroot planting in the first association season). Therefore, intercropping allowed anticipating the entry of financial resources for the producer, which is of fundamental importance, since arrowroot has cycle of more than 300 DAP and financial return only after this period.

Due to greater ease of industrialization, arrowroot starch was gradually replaced by cassava starch, causing arrowroot to practically disappear from the market (Cunha, 2016). However, cassava starch does not have the same digestibility and gelatinization characteristics as arrowroot starch. The rescue of arrowroot cultivation as a source of income for small rural producers is today a very interesting option due to the high added value of starch. This work showed that it is agronomically and also economically viable the association of arrowroot cultivation with green corn, proceeding the planting of green corn at 60 DAE of arrowroot. At this time, the development of arrowroot plants and the production of starch are not affected, with an anticipated return of income for the producer.

Thus, it could be concluded that intercropping green corn with arrowroot established at 0; 30; 60 and 90 days after the emergence of arrowroot plants are agronomically viable because they have Efficient Land Use Index above the unit, and green corn plants are not affected by the association with arrowroot, in all studied seasons. The production of arrowroot rhizomes and starch is affected when the association with green corn is established at 0; 30 and 90 days after the emergence of arrowroot plants. In economic terms, the association of green corn with arrowroot should be preferably performed at 60 days after the emergence of arrowroot plants.

ACKNOWLEDGMENTS

To FAPEAM for the doctoral scholarship to the first author, to CNPq for the PQ scholarship to the second author.

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