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Lettuce (*Lactuca sativa* L.) fertilization system with organic matter based on poultry litter

Luiz Leonardo Ferreira[1], Juliana Naves de Campos[1], Carmen Rosa da Silva Curvêlo[3*], Alexandre Igor de Azevedo Pereira[3], Raphael Augusto de Castro e Melo[4]

[1]Doutor emFitotecnia, Docente Titular do Centro Universitário de Mineiros - UNIFIMES, Mineiros – GO

[2]Graduando emAgronomia,CentroUniversitário de Mineiros - UNIFIMES, Mineiros – GO

[3] nstituto Federal Goiano – Campus Urutaí, - Urutaí – GO, Brazil

[4]Embrapa Hortaliças, Brasília-DF, Brasil

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Abstract

Lettuce is the hardwood vegetable of greater acceptance by the consumer, because it presents high contents of source of vitamins and minerals, besides owning low calorie. Several authors report the application of organic fertilizers providing increases in productivity and quality of this crop. The objective of this work was to evaluate the system of lettuce fertilization with organic matter based on avian bed. The experiment was conducted at the Fazenda Flores, located in the municipality of Mineiros - GO. The experimental design was a randomized block in factorial 3x5, totaling 15 treatments, corresponding to three lettuce cultivars (green-leaf, head or romaine and purple) submitted to five levels of organic matter based on poultry litter (0, 30, 60, 90 and 120 m^3 h^{-1}). The following variables were evaluated: stem diameter (DC), stem height (AC), commercial leaf number (NF), fresh head matter (MFC) and productivity. Thus, the application of approximately 85 m3 ha^{-1} of avian bed-based organic matter in the cultivation of cv. Crespa and Head. The cultivation of cv. Roxa, because it presents characteristics of low environmental adaptability during the growing period.

* **Corresponding Author:** Carmen Rosa da Silva Curvêlo ✉ carmencurvelo@yahoo.com.br

Introduction

The production of vegetables is an alternative for the small producers, since there is no demand for large areas, in addition, lettuce cultivation presents a great economic return per cultivated área. It is, therefore, an agricultural activity, as well as characteristics of the Southwest region of Goiás, that also is also characterized by owning small goods with family labor.

A lettuce (*Lactuca sativa* L.) has great importance in human nutrition, standing out as a source of vitamins and minerals, besides being the most popular hardwood vegetable consumed in the country (Ziech *et al*., 2014). However, its commercial pattern has a positive influence of fertilization, since it is an aerial part of the plant and bigger and heavier when there is a large integer of organic compound incorporated in the soil (Santana *et al*., 2012).

The use of organic manure from animal manures and organic compounds of different origins has been used without crop cultivation on many farms (Ziech *et al*., 2014). This is because organic matter contributes decisively to many soil physical-chemical properties, such as cation exchange capacity, complex formation, and chelates with various ions and moisture retention. In addition, to minimize environmental pollution and reduce costs with mineral fertilizers, thus making the use of organic fertilizers a very attractive option from an economic point of view due to the cycling of nutrients (Silva *et al*., 2010).

There is no lettuce cultivation to minimize the problems related to excessive soil management, emphasizing the application of organic fertilizers (Ziech *et al*., 2014). Several authors report an application of organic fertilizers providing increases in productivity and paper quality (Yuri *et al*., 2004; Santana *et al*., 2012; PeixotoFilho *et al*., 2013).

According to Torales *et al.* (2010), the production of commercial roots of mandioquinha-salsa as a function of the doses of bed of chicken in cover, verified that the highest indices were observed in the dose of 20 t ha^{-1} of the organic residue.

Meanwhile, studies carried out under the conditions of Dourados-MS, satisfactory results were obtained in productivity and financial income with the use of litter bed on the ground in the vegetables chives and arugula (Heredia Zárate *et al*., 2006).

Blum *et al.* (2003), field conditions, concluded that the incorporation of avian litter into the soil increased the pH, reduced the levels of Al exchangeable and increased the availability of macronutrients (N,P,K and Ca) and micronutrients (Zn and Mn).

In view of the above, there is a shortage of deeper studies to evaluate the residual effect of organic fertilization with litter on lettuce production in Brazil. The objective of this work was to evaluate the lettuce (*Lactuca sativa*) cultivation system fertilized with organic matter based on avian bed, under the conditions of the municipality of Mineiros – GO.

Material and methods

Place of conduction of the experiment

The experiment was carried out at Fazenda Flores, located in the municipality of Mineiros-GO, located at BR-364 in front of the fork for 10 km x343648 and 8056557 zone 22k. UTM coordinate.

The soil of the experimental area was classified as Dystrophic Red Latosol (EMBRAPA, 2013). The region had an annual average temperature of 24.2ºC and average rainfall of 1,700 mm. The predominant climate is warm, semi-humid and notably seasonal, with rainy summer and dry winter, being classified as "Aw", according to Köppen classification.

Experimental design

The experimental design was a 3×5 factorial, totaling 15 treatments, corresponding to 3 cultivars of lettuce (green-leaf, head or romaine and purple) submitted to 5 doses of organic matter based on poultry litter (0, 30, 60, 90 and 120 m^3 ha^{-1}), in 4 replicates, totaling 60 experimental units, where each unit was composed of 11 plants.

Cultural practices and conduction of the experiment

The soil sample of the experimental area was collected in the superficial layer of 0-20 cm. In the collection of the sampling of the poultry litter, five well-distributed points were chosen on the pile in order to make a composite sample. Afterwards, the samples were sent to the Laboratory of Chemistry and Soil Fertility of UNIFIMES, to perform the chemical and fertility analyzes, according to the methodology of Embrapa (2009).

The preparation of the soil consisted of plowing and harrowing, followed by the furrow at a depth of 0.20 m, assembling the litter with mechanized agricultural implements. Soil fertilization was carried out seven days before transferring the lettuce seedlings. This was performed on the basis of poultry litter as described in the treatments.

Irrigation was done by micro-sprinkler with half-inch (1/2") hoses. The sprinklers were distributed every 3 m. It has a flow rate of 63 L h^{-1} m-2 with a watering period of three hours daily, with two shifts, morning and afternoon.The poultry litter originated from the production of chicken, having its origin of aviary from the municipality of Mineiros-GO and having a history of three consecutive lots. This was transported to the experimental unit, heaped and arranged to shade. Weekly it was stirred and moistened, in order to complete a homogenous process of composting, taking 45 days for its maturation.

The seeds were purchased in the local market. The lettuce seedlings were sprouted and seeded in styrofoam trays of 128 cells, using as substrate only organic compound.

Three seeds were sown per cell and at ten days after sowing the thinning practice was performed, leaving a single plant per cell. The transplant was performed 25 days after sowing. The irrigation for the production of the seedlings was performed by hand irrigator.

The plants were distributed in a field with quiconic conformation spaced in 35×35 cm, comprising 11 plants per plot. It was also used mulch based on rice straw in order to minimize the effects of raindrops on soil, moisture conservation and weed control. At the same time, manual weeding was performed. Data were collected at 35 days after transplantation. The variables consisted of stem diameter (DC), stem height (AC), commercial leaf number (NF), fresh head matter (MFC) and productivity (BENINCASA, 2004).

Statistical analysis

The results were submitted to analysis of variance, where the description of the variables was performed as a function of the doses of organic matter based on poultry litter, and the polynomial regression was performed by testing the linear and quadratic models. Which presented the highest correlation with the means, observing the significance of the F test. All analyzes were done with the statistical program System for Analysis of Variance - SISVAR (FERREIRA, 2011).

Results and discussion

In the cultivar system of the lettuce cultivars studied in this work, we observed that the increase of avian manure promoted a significant increase in all varietals analyzed for the cultivar Roxa in relation to the other cultivars analyzed (Table 1).

Table 1. Plant components of lettuce cultivars according to organic fertilization. Mineiros – GO, 2016.

Cultivar	Stem		Leaf	Head	Yield
	Height	Diameter			
	cm	mm	units $plant^{-1}$	g	t ha^{-1}
Vanda	7.75 b	2.55 a	30.35 b	353.25 b	31.40 b
Lucy Brown	5.35 c	2.07 b	24.95 c	346.30 b	30.78 b
RQE*	31.25 a	2.65 a	42.85 a	380.50 a	33.82 a
CV	14.24	5.91	7.30	5.58	5.58

Means followed by the same letters in the column do not differ from each other by the test f Tukey at 5% of probability. * RQE - Purple Four Seasons.

All lettuce cultivars had a quadratic effect according to the organic fertilization rates in the stem diameter variable. The optimization points were found in 86.83, 71.83 and 95.50 m^3 ha^{-1} of organic matter, corresponding to 3.49, 2.43 and 3.81 cm of DC, in cv. green-leaf, romaince, and red, respectively (Fig. 1).

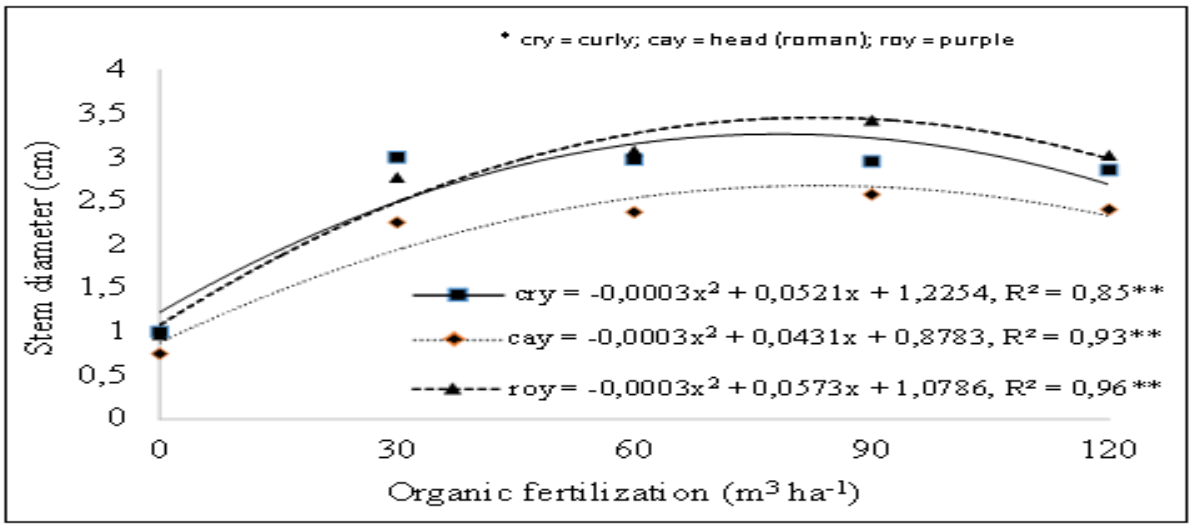

Fig. 1. Stem diameter of lettuce cultivars as a function of organic fertilization. Mineiros – GO, 2016.

This characteristic also known as the secondary growth of the plant allows the more extended, a better flow of hydration of the leaves. The aerial part is very sensitive to the loss of water, which directly influences the productivity of this crop. Ziech *et al.* (2014) studying different management soil cover and sources of fertilization in the agronomic parameters of cv. green-leaf lettuce verified in the base fertilization of poultry litter the DC was of 2.00 cm, in the second consecutive cultivation.

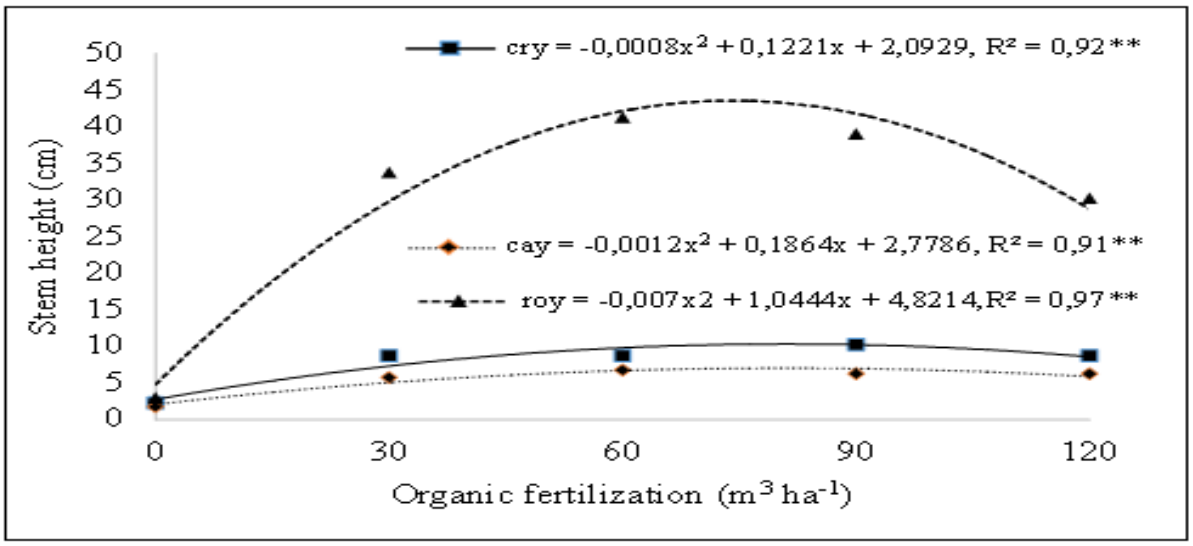

Fig. 2. Stem height of lettuce cultivars as a function of organic fertilization. Mineiros – GO, 2016.

At the height of stem - AC to cv. green-leaf lettuce was obtained quadratic effect following the curve of normality in the dose of 76.31 m^3 ha^{-1} of organic matter, thus presenting a AC of 6.75 cm. In the same the cv. romaine lettuce at the dose m3 ha^{-1} of organic matter (AC: 10.02 cm) and cv. red lettuce in 74.60 m^3 ha^{-1} of organic matter (AC: 43.78 cm) (Fig. 2). This information demonstrates that cv. red lettuce presented a stress, once, that the increase of the stem above 15 cm, results in the beginning of transition,

from the vegetative to the reproductive phase, besides, to increase the rate of lactucine, a substance of low human palatability. The results corroborate with Heredia Zárate *et al.* (2007), which also found a significant effect on the height of lettuce plants cv. iceberg lettuce, when fertilizing the soil with poultry litter finding an average of 13.24 cm in the presence and 9.94 cm in the absence of this.

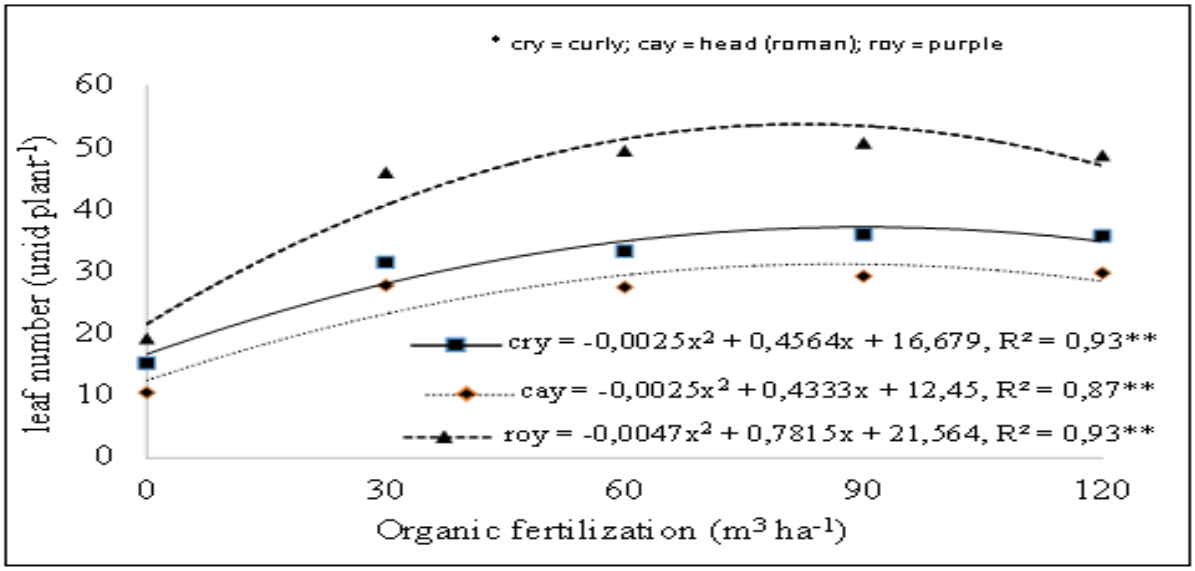

Fig. 3. Commercial leaflet number of lettuce cultivars as a function of organic fertilization. Mineiros – GO, 2016.

The cv. Purple lettuce was the genotype with the highest number of leafs - NF reaching the highest average in the dose of 83.14 m^3 ha^{-1} of organic matter, in the order of 54.05 $plant^{-1}$ leaves. Followed by cv. green-leaf lettuce with 37.51 leaves $plant^{-1}$ and cv. Consequently, it was observed the presence of organic matter (31.22 leaves $plant^{-1}$, 91.28 and 86.66 m^3 ha^{-1}) (Fig. 3). In a study carried out by Peixoto Filho *et al.* (2013) it was verified that the number of leaves per lettuce plant fertilized with chicken, cattle and sheep manure did not differ from the mineral fertilizer in the first crop, and the treatment that received the manure based on chicken manure provided an average of 15 leaves $plant^{-1}$. Ziech *et al.* (2014) fertilizing the soil with poultry litter found numbers in cv. green-leaf lettuce that varied from 15 to 23 leaves $plant^{-1}$ in the first and second crop, respectively.

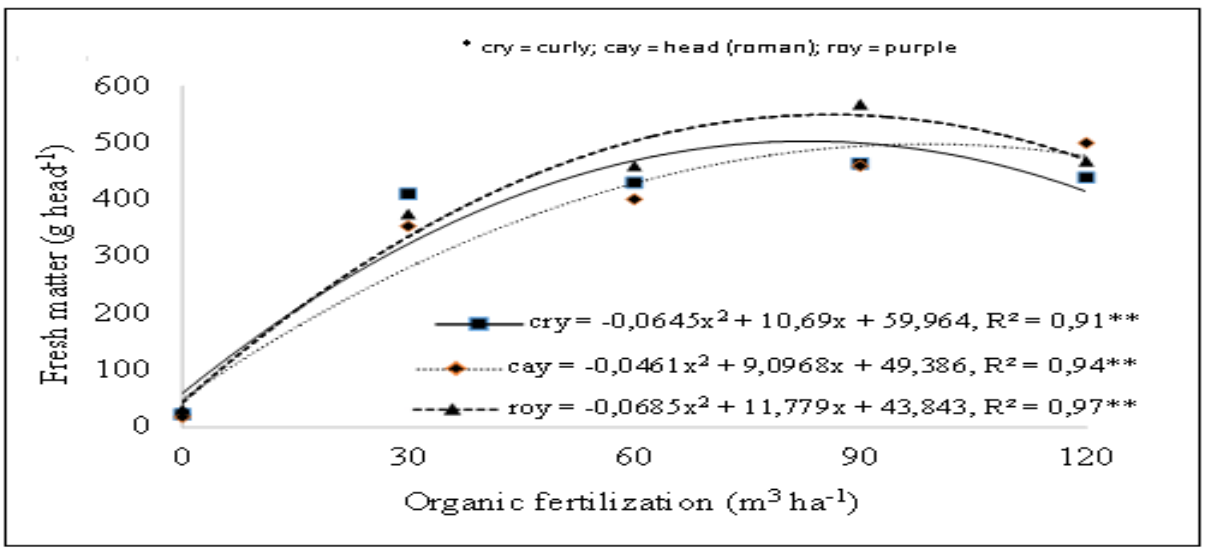

Fig. 4. Fresh matter of the head of lettuce cultivars as a function of organic fertilization. Mineiros – GO, 2016.

After the appearance of a compact and uniform head of lettuce in terms of size and coloring, the head mass is one of the characteristics most desired by lettuce producers and consumers. In this variable, cv. red lettuce presented 550.21 g head^{-1} with the dose of organic matter optimized in 85.98 m^3 ha^{-1}, a cv. green-leaf lettuce reached the weight of MFC in the dose of 82.87 m^3 ha^{-1} with average weight of 502.89 g head^{-1}, and cv. romaine lettuce with 498.15 g head^{-1} at dose 98.66 m3 ha^{-1} (Fig. 4). Turazi *et al.* (2006) in the conditions of Brasilia obtained an average of 253, 43 g head^{-1} of MFC, when also, in the opportunity, they worked with poultry litter to fertilize the soil. Ziech *et al.* (2014) with organic fertilization having as source poultry litter found CFM with a mean of 152 g head^{-1} in the first cycle and 282 g head^{-1} in the second.

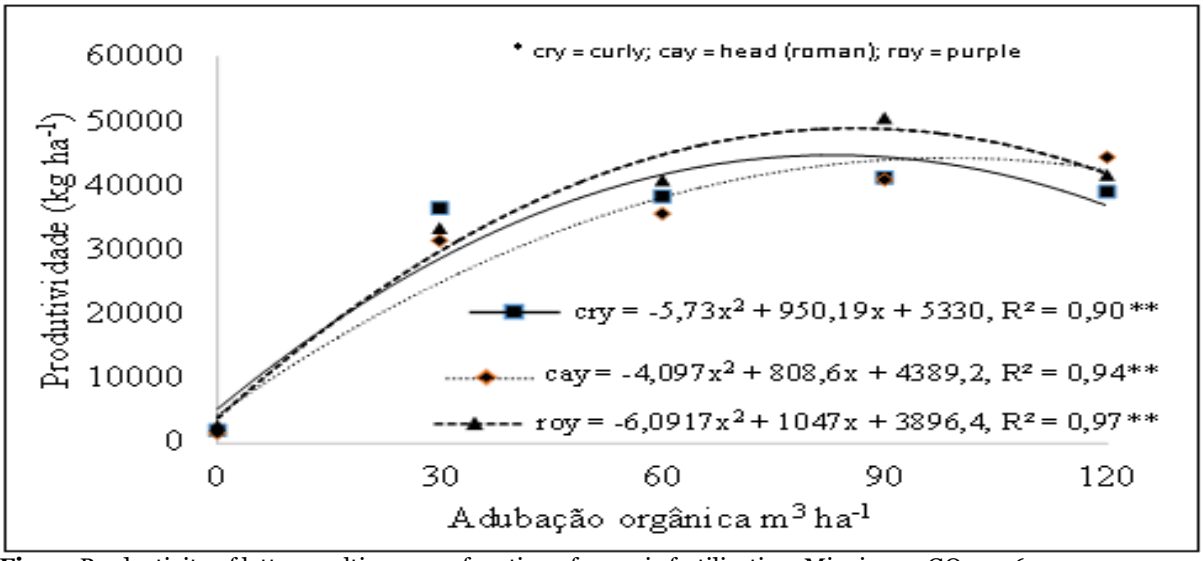

Fig. 5. Productivity of lettuce cultivars as a function of organic fertilization. Mineiros – GO, 2016.

The productivity values were adequate in the quadratic models of normality, where cv. green-leaf lettuce in the amount of 82.91 m^3 ha^{-1} of organic matter reached productivity of 44.721,84 kg ha^{-1}, cv. romaine lettuce with 98.68 m^3 ha^{-1} of organic matter (44.286,32 kg ha^{-1}) and cv. red lettuce 85.94 m^3 ha^{-1} of organic matter (48,884.21 kg ha^{-1}) (Fig. 5). However, the latter, even though presenting an average higher than the others, is compromised, once that these plants raised their stems to heights that devalue the product, before reaching the consumer market.

Peixoto Filho *et al.* (2013) working with poultry litter, found superior productivity to treatments with cattle manure and sheep equating the mineral fertilization with an average of 26,720,000 kg ha^{-1} of cv. green-leaf lettuce. Turazi*et al.* (2006) working with cv. green-leaf lettuce fertilized with poultry litter obtained an average of 15,200 kg ha^{-1}, surpassing even the treatment that received mineral fertilization. Ziech *et al.* (2014) with poultry litter reported productivity of 42,154,000 kg ha^{-1} of cv. green-leaf lettuce.

Conclusion

All lettuce cultivars had a quadratic effect as a function of organic fertilization rates for all studied variables, with the exception of the stem height variable in cv. purple that presented a stress, once, that the increase of the stem above 15 cm, results in the beginning of transition, from the vegetative to the reproductive phase, besides, to increase the rate of lactucine, a substance of low human palatability.

For the study conditions, it is recommended the application of approximately 85 m^3 ha^{-1} of organic matter based on poultry litter in the cultivation of cv. green-leaf and romaine lettuce. The cultivation of cv. purple lettuce presents characteristics of low environmental adaptability during the growingseason of the mentioned agricultural year.

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