



ECONOMIC ANALYSIS OF THE MAINTENANCE OF *CENCHRUS PURPUREUS* GERMOPLASM BANK OF THE INSTITUTE OF ANIMAL SCIENCE

ANÁLISIS ECONÓMICO DEL MANTENIMIENTO DEL BANCO DE GERMOPLASMA DE *CENCHRUS PURPUREUS* DEL INSTITUTO DE CIENCIA ANIMAL

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The maintenance of the *Cenchrus purpureus* germplasm collection of the Institute of Animal Science of the Republic of Cuba was economically analyzed. For the research, the direct costs involved in maintaining the accessions of the germplasm bank were considered. Annual cultural maintenance labors were taken into account. The accumulation of expenses was prepared, in Cuban pesos, based on the investment in salary, fuel, machinery and other inputs. In the analysis, a total annual expense of \$45,840.66 Cuban pesos was found. Of the total expenses, salary and other inputs constituted the largest outlay, with \$29,260.01 and \$10,350.56 Cuban pesos, respectively. The maintenance labors with the highest expenses were the cleaning of plots, mechanical control of weeds and irrigation. It is concluded that it is necessary to make modifications in the schedule of annual cultural labors to reduce expenses in salary and other inputs.

Keywords: cultural labors, ex situ conservation, expenses, plant genetic resources, profitability

Se analizó económicamente el mantenimiento de la colección de germoplasma de *Cenchrus purpureus* del Instituto de Ciencia Animal de la República de Cuba. Para la investigación se consideraron los costos directos involucrados en el sostenimiento de las accesiones del banco de germoplasma. Se tuvieron en cuenta las labores culturales anuales de mantenimiento. Se confeccionó la ficha de acumulación de gastos, en pesos cubanos, a partir de la inversión en salario, combustible, maquinaria y otros insumos. En el análisis se encontró un gasto total anual de \$45 840.66 pesos cubanos. Del total de gastos, el salario y otros insumos constituyeron el mayor desembolso, con \$29 260.01 y \$10 350.56 pesos cubanos, respectivamente. Las labores de mantenimiento con mayores gastos fueron la limpieza de parcelas, control mecánico de arvenses y riego. Se concluye que es necesario realizar modificaciones en el cronograma de labores culturales anuales para reducir gastos en salario y otros insumos.

Palabras clave: conservación ex situ, gastos, labores culturales, recursos fitogenéticos, rentabilidad

Out of the 140 known *Cenchrus* species, *Cenchrus purpureus* (Schumacher) Morrone is one of the most important (Umer and Nurusheva 2020) for the production of animal feed, mainly as forage or through direct grazing. In the world, several conservation centers (universities, research centers and farms, among others) maintain and develop promising cultivars of *C. purpureus* to use their potential for forage production. In Cuba, there are important collections of *C. purpureus* germplasm, preserved mainly at the Institute of Animal Science (ICA). These collections are important sources of plant genetic resources and are available for

genetic improvement and the distribution of certified seed (Fernández 2022).

Ex situ germplasm conservation is based on the maintenance of biological material in plant collections (in the field, nursery or botanical gardens), seed banks and *in vitro* culture banks. The maintenance of field germplasm banks can be costly and demanding in terms of labor and financial resources, since the stored plants require optimal agronomic management, due to their exposure to attack by pests, diseases and natural disasters, among others (Suárez 2020).

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Therefore, the objective of this study was to economically analyze the maintenance of the *Cenchrus purpureus* germplasm collection at the ICA.

The study was developed in the *C. purpureus* germplasm bank, established at the "Miguel Sistachs Naya" Experimental Center for Pastures and Forages of the ICA, located in San José de las Lajas municipality, Mayabeque province, Cuba, in a typical red ferralitic soil (Hernández et al. 2015). The germplasm conservation area of *C. purpureus* complies with the standards for germplasm banks of plant genetic resources for food and agriculture (FAO 2014).

Direct costs involved in maintaining the *C. purpureus* accessions in the germplasm bank were considered. The technical sheet of the cultural maintenance labors of the bank (mechanical weed control, plot cleaning, fertilization, cutting and irrigation), which are carried out during one year, was also taken into consideration (table 1).

The accumulation sheet of expenses in Cuban pesos was prepared based on the investment in salary, fuel, machinery and other inputs. Regarding other inputs in irrigation, the expenses in water (51.48 m³/h for 1.20 Cuban pesos per m³), electricity (30 kW/h for 3.10 Cuban pesos per kW) and purchase of fertilizer were used.

The salary of a worker was obtained from Resolution No. 29-2020 (Ministry of Labor and Social Security 2020a). The value of a liter of fuel was based on the provisions of Resolution No. 350-2020 (Ministry of Finance and Prices 2020b). The price of nitrogen fertilizer was obtained from Resolution No. 344-2020 (Ministry of Finance and Prices 2020c), in force in Cuba. The data was processed using the Microsoft Excel package.

In the economic analysis, the sheet of expenses accumulation for the maintenance of *C. purpureus* accessions in the germplasm bank was determined (table 2). A total annual expense of \$45,840.66 Cuban pesos was found for all the cultural maintenance labors carried out in the area. Human labor expenses, expressed in salary, constitute one of the elements with the greatest impact on the maintenance of the *C. purpureus* germplasm collection at the ICA. Regarding salary, the economic analysis showed that the maintenance labors with the greatest expense are plot cleaning, followed by the mechanical weed control and cutting of *C. purpureus* accessions.

At the International Maize and Wheat Improvement Center (CIMMYT, initials in Spanish) in Mexico, Pardey et al. (2001) estimated that the annual expenditure for conserving wheat germplasm in the germplasm bank was US \$270,138.00, about 64% of the annual amount included human labor. Maintenance practices are often species-specific and may vary depending on the use given to the collection: conservation, evaluation, distribution (FAO 2014).

Irrigation represented a significant amount in the analysis, marked by the value of water and the expense of electricity, which is necessary for this work. In the study, it was considered that irrigation is applied according to the needs of the area in both periods of the year. Twelve annual irrigations were carried out, but it is not possible to define a specific amount per season, due to the variations in the behavior of climatic factors that can occur from one year to the other. As stated by FAO (2014), the irrigation application system must be appropriate for the type of plant and the ecological conditions where the germplasm bank has been established.

Table 1. Technical sheet for the maintenance of the *C. purpureus* germplasm bank at ICA

Labors	Frequency			Time, hours	Human labor	Fuel, liters	Water, m ³ /h	Energy, kW/h
	Dry season	Rainy season	Year					
Mechanical weed control with tractor	Once a month	Twice a month	18	3	1	10		
Mechanical weed control with manual brush cutter	Once a month	Twice a month	18	8	1	2		
Plot cleaning		48 in the year		15	2			
Cut	2	3	5	10	4			
Fertilization	1	1	2	4	2	1.54		
Irrigation		12 times in the year		5	1		51.48	30

Table 2. Expense accumulation sheet for the maintenance of the *C. purpureus* germplasm bank of the ICA

Labors	Salary	Fuel	Machinery	Other inputs	Total
Total mechanical weed control	2,743.13	3,045.96	38.21	0.00	5,827.30
Mechanical weed control with tractor	748.13	2,518.20	18.28	0.00	3,284.61
Mechanical weed control with manual brush cutter	1,995.00	527.76	19.93	0.00	2,542.69
Plot cleaning	19,950.00	0.00	0.00	0.00	19,950.00
Fertilization	221.67	43.09	6.58	1,064.00	1,335.34
Cut	2,770.83	0.00	0.00	0.00	2,770.83
Irrigation	831.25	0.00	12.08	9,286.56	10,129.89
Total	29,260.01	6,135.01	95.08	10,350.56	45,840.66

In an analysis carried out by [Herrera and Ramos \(2015\)](#) to determine the response to irrigation applied in dry season in two varieties of *C. purpureus*, Napier and King grass, it was found that irrigation produced approximately twice the yield, compared to the absence of irrigation. This was related to the better use of available nutrients, since this species requires high amounts of water to express its productive potential. However, in most cases, irrigation is expensive due to the use of energy sources and specific equipment.

In the economic analysis, the amount of fertilization labor is the lowest among all the analyzed indicators. However, the value of other inputs is the highest and is determined by the value of nitrogen fertilizer in the national market. According to Resolution No. 344-2020 ([Ministry of Finance and Prices 2020c](#)), fertilizers such as urea can cost up to \$6,519.33 Cuban pesos per ton. The complete nationally produced formulas of NPK 9-23-16 and NPK 9-13-17 are sold at \$11,200.24 and \$8,602.19 Cuban pesos per ton, respectively.

Strategic fertilization with chemical fertilizer, which is applied with irrigation, is used in *C. purpureus* germplasm bank of the ICA. This strategy guarantees adequate regrowth and plant vigor. [Alves et al. \(2022\)](#) and [Herrera \(2022\)](#) pointed out a significant increase in yield components of *C. purpureus* accessions, with strategic application of chemical fertilizer.

When analyzing the work of mechanical control of total weeds, it was demonstrated that the expenses are higher with the use of the tractor, determined by the value of fuel and the time for its completion. Regarding fuel, there is a price difference. According to Resolution No. 350-2020 ([Ministry of Finance and Prices 2020b](#)), the price of motor gasoline ranges from \$14.66 to \$17.37 Cuban pesos per liter. However, diesel has a price between \$13.99 and \$15.12 Cuban pesos per liter.

Greater expenses were evident in terms of salary for the use of the manual brush cutter, which is defined by the hours of labor used by the operator to complete the work. In this sense, the operator needs eight hours to complete the work compared to the three hours required by the tractor. These differences in time influence on efficiency and are translated into higher salary expenditure, as established in Resolution No. 29-2020 ([Ministry of Labor and Social Security 2020a](#)).

In the *C. purpureus* germplasm collection of the ICA, two forms of mechanical weed control are used to ensure that the area is in optimal conditions. According to [FAO \(2014\)](#), weed control is important for the rapid and vigorous growth of the plant. Weed control can be carried out by mechanical methods or by using chemical products (herbicides). However, the latter increase the maintenance costs of the *C. purpureus* bank of the ICA due to their value. According to Resolution No. 344-2020 ([Ministry of Finance and Prices 2020c](#)), retail prices of herbicides in Cuba can

range from \$109.56 to \$9,948.45 Cuban pesos, per kilogram or liter.

It is concluded that it is necessary to make changes to the schedule of annual cultural labors in the *C. purpureus* germplasm bank of the ICA to optimize investments and reduce expenses in salaries and other inputs. In addition, the figures provided in this study are recommended for use as supporting data for future analyses and investments in this area.

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