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Jala landrace maize corncob contest contributes to *in-situ* conservation

El concurso del elote del maíz raza Jala contribuye a la conservación *in situ*

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ABSTRACT

Jala landrace maize, native to Jala, Nayarit, Mexico, is distinguished by its ear and corncob length. This study analyzes changes over time in both characteristics and links the corncob contest to its *in-situ* conservation. A questionnaire was applied to producers who planted this maize in 2017. In 2012 and 2023, ears harvested *in-situ* were described. Informal interviews were conducted. Information derived from participation in the corncob competition coordination was systematized. The maximum maize length recorded since 1981 was obtained in 2023 and it was 49 cm. In 2023, a 50 cm ear was produced. It was shorter than the maximum recorded in 1907 (55.9 cm). The recorded corncob lengths were relatively stable over time, without providing elements to assert that the contest contributes to improving the expression of ear length, as there are no harvest records derived from producers' plots. The decline in the current area cultivated with the Jala landrace threatens its *in-situ* conservation. Tradition, focused on the corncob contest, is essential for the *in-situ* conservation of this phytogenetic resource, unique in the world.

KEY WORDS: Jala landrace, *in-situ* conservation, distinctive character, corncob fair, tradition.

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Revista Bio ciencias
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RESUMEN

El maíz raza Jala, nativo de Jala, Nayarit, México, se distingue por la longitud de elote y mazorca. Este estudio analiza los cambios a través del tiempo en ambas características y relaciona al concurso del elote con su conservación *in situ*. Se aplicó un cuestionario a productores que en 2017 sembraron ese maíz. En 2012 y 2023 se describieron mazorcas cosechadas *in situ*. Se aplicaron entrevistas informales. Se sistematizó información derivada de la participación en la coordinación del concurso del elote. La longitud máxima de elote registrada desde 1981 se obtuvo en 2023 y fue de 49 cm. En 2023 se produjo una mazorca de 50 cm, inferior a la máxima registrada en 1907 (55.9 cm). Las longitudes de elote registradas fueron relativamente estables a través del tiempo, sin aportar elementos para aseverar que el concurso contribuye a mejorar la expresión de la longitud de mazorca, al no existir registros a cosecha derivados de parcelas de productores. La disminución en la superficie actual cultivada con la raza Jala amenaza su conservación *in situ*. La tradición, focalizada en el concurso del elote, es fundamental para la conservación *in situ* de este recurso fitogenético, único en el mundo.

PALABLAS CLAVE: Raza Jala, conservación *in situ*, carácter distintivo, feria del elote, tradición.

Introduction

Native maize refers to the landraces of the taxonomic category *Zea mays*, subspecies *mays*, that Indigenous peoples, peasants, and farmers have cultivated and continue to cultivate, from seeds selected by themselves or obtained through exchange, in constant evolution and diversification (POGG, 2022). In Mexico, native maize is the staple crop par excellence, and due to its multiple qualities, it is used in a variety of ways; for example, as tortilla (Vázquez *et al*., 2010), corncob (Ortiz-Torres *et al*., 2013), and pozole (Santiago-López *et al*., 2023). The bracts of the ear (totomoxtle) are used to manufacture handicrafts (Hasan & Hasdiana, 2020); its fiber, comparable to that of linen and cotton, gives it potential for making biodegradable clothing (Reddy & Yang, 2005), and there is a great variability in the characteristics of totomoxtle between and within maize populations (Flores-Rosales *et al*., 2015). The forage or stubble is used for livestock feed, especially when it has high digestibility and nutritional quality (Guerrero-Rodríguez *et al*., 2023). The cob or rachis serves as a fire generator; the grain, due to its color variation, is used in jewelry; tostadas (toasts), fried foods, and typical drinks such as tejuino are made; and it has a relevant industrial use for oil or pigment extraction (Hernández-Guzmán *et al*., 2017). The range of uses for maize adds value to their crop and improves the peasant economy in rural areas.

Revista Bio ciencias
ISSN 2007-3380

The versatility of maize uses is explained by the wide genetic diversity that exists between and within native populations. To study and systematize this diversity, the concept of landrace is used. This refers to a group of related individuals with sufficient common characteristics that allow their recognition as a group and that have a high number of common genes (Anderson & Cutler, 1942). Landrace is a dynamic population of a cultivated plant that has a historical origin, distinct identity, and lacks formal plant breeding; it is often genetically diverse, locally adapted, and associated with traditional cultivation systems (Camacho *et al*., 2006). Based on the Mexican regulations DOF-Mexico (DOF, 2020), landrace refers to individuals or populations that share common morphological, ecological, genetic, and cultivation history characteristics, through which they can be differentiated as a group.

In general, landrace conservation is essential to ensure crop diversity, food security, and sustainable production (Ocampo-Giraldo *et al*., 2020). For this reason, a key component of agrobiodiversity is represented by landraces or local populations (Marone *et al*., 2021). In this context, and specifically for maize, 285 landraces have been described in the Western Hemisphere (Pandey & Gardner, 1992), and nearly 300 have been reported worldwide (Dowswell *et al*., 1996). In Mexico, at least 59 landraces have been described (Sánchez *et al*., 2000); one of these is the Jala landrace, named after the ethnobotanical exploration carried out by Wellhausen *et al*. (1951). In this classic and historic work on the study and understanding of maize diversity in Mexico, the first 25 landraces were classified into the following groups: Ancient Indigenous Landraces, Pre-Colombian Exotic Landraces, Prehistoric Mestizo Landraces, and Incipient Modern Landraces; Jala landrace was classified within the group of Prehistoric Mestizo Landraces. In this same study, seven groups were declared as poorly defined landraces.

Jala landrace maize is known locally as “wet maize” because it is planted in April, taking advantage of the residual moisture available in the soil (Hernández-Guzmán *et al*., 2017). In 1907, its plant height was 6 m and the ear length 50.8 cm, although one ear measuring 55.9 cm was found (Kempton, 1924). The Jala landrace has been studied for different purposes (Rice *et al*., 2006; Aguilar-Castillo *et al*., 2006; Montes-Hernández *et al*. 2014; López *et al*., 2017; Rojas-Polanco *et al*., 2022; Camacho-Villa *et al*., 2024), due to the length of its ear and different qualities associated with its use. Specifically, in addition to its use as fodder and consumption as corncob (Valdivia-Bernal *et al*., 2010), the elaboration of pozole, its transformation into oven-baked gorditas which are very traditional in the Jala town, the preparation of tejuino, the sale of the ear due to its large size, and the commercialization of its bracts or totomoxtle, due to its distinctive character and in particular the length of the corncob, the Jala landrace is currently used for the traditional and historical event known as “The largest corncob contest in the world” (Hernández-Guzmán *et al*., 2017). This contest is especially relevant because changes in the socioeconomic and environmental conditions in the Jala Valley could lead to the genetic erosion of the ancestral Jala landrace, which may have global consequences (Ocampo-Giraldo *et al*., 2020).

Therefore, in 1981, to encourage the planting of Jala landrace maize, the then Mayor, proposed the corncob contest (Listman & Pineda, 1992; SAGARPA, 2014). This contest also allows for the generation of evidence related to the evolution of corncob length; whereas, concerning ear length, since Kempton’s report (1924), which emphasized the maximum length

Revista Bio ciencias
ISSN 2007-3380

that the Jala landrace has been able to produce to date, there has been no systematic record of the changes that have occurred in this distinctive characteristic of that maize landrace. The following question arises: What changes does the ear length of Jala landrace maize have over time? There is no documented evidence to answer this question. Nevertheless, understanding the variation in corncob length over time can indirectly contribute to explaining the changes in ear length. The objectives of this research were to document maximum corncob lengths during a period of the annual contest held in Jala, Nayarit, together with the perception of producers regarding the importance of the contest in the conservation of Jala landrace maize; to evaluate ear characters from recombination lots that have been systematically established in Jala as an *in-situ* conservation strategy; and to compare the change in some of these characters taking as reference the historical information reported by Kempton (1924) and Wellhausen ***et al***. (1951). The hypothesis is that the corncob contest contributes to the *in-situ* conservation of Jala landrace maize, as well as to the conservation of ear length as a distinctive characteristic of this maize landrace.

Material and Methods

Study area description

Jala is one of the 20 municipalities that make up the State of Nayarit. It is located between 21°03'-21°22' N and 104°14'-104°34' W, with altitudes between 300 and 2,500 m (INEGI, 2010). The predominant climate is Acw1, which corresponds to a semi-warm sub-humid climate, with summer rains and an average annual precipitation of 837.4 mm (García, 2008).

Ear Length

As a reference, the classic and historical sources of Kemton (1924) and Wellhausen ***et al***. (1951), which refer to the Jala landrace, were consulted. To know the current status of ear traits, isolated recombination lots were established *in-situ* in 2012 and 2023, using in each case balanced compounds formed by an equal number of seeds from 300 outstanding ears and phenotype adjusted to Jala landrace maize, harvested in Jala, Nayarit in 2011 and 2022, respectively. The planting of these lots took place in the last week of March, in plots located in the Jala valley, at 1,100 masl and under residual humidity conditions. The furrows were plowed with animal traction, and the seed was deposited through a funnel fitted to the plow. The first weeding and initial fertilization took place in June (until the onset of rainfall) and the second in July, applying a dose of 120-40-40, using Triple 17 and Ammonium Sulfate as sources. The 40-40-40 dose was applied in the first weeding, and the 80-00-00 dose in the second. Weed control was carried out culturally. In 2012 and 2023, from those lots and in that order, 295 and 219 ears were selected. To obtain these ears, visual selection was carried out at harvest based on the outstanding ear length and characteristic phenotype of Jala landrace maize. A second selection was carried out, with emphasis on the number of rows, type, and grain color, to conserve only the most representative specimens of the Jala landrace.

Revista Bio ciencias
ISSN 2007-3380

Corncob contest

We documented what the traditional corn contest consists of, based on the call for entries that is issued and disseminated, where in the elaboration process the first author of this publication participated directly and consecutively over the last 18 years. From 2007 to 2024 (except from 2020 to 2022 due to the SARS-CoV-2 pandemic), the first author of this contribution coordinated the corncob contest and served as president of the jury. This participation provided the opportunity to collect direct information such as the name of the producer, locality of origin, and length of the winning corncob over those years; this information was immediately recorded after each event. In the years in which he did not participate in the coordination of the contest, the required information was requested from the Rural Development Department of the H. City Council of Jala, Nayarit.

Corncob contest and Jala landrace maize conservation

In 2017, a questionnaire was applied to the 24 producers who planted Jala landrace maize that year. The instrument provided information to support how tradition relates to the *in-situ* conservation of this landrace. In addition, for this study, pertinent information was gathered by the second author of this paper, through informal interviews that she conducted in 1999 to producers who, popularly and traditionally, in the opinion of other producers, at that time were protagonists in the planting and conservation of Jala landrace maize. When required, a percentage analysis of the information was carried out.

Results and discussion

Ear length

The earliest historical record of ear length for the Jala landrace was made by Kempton (1924), who visited Jala in October 1907 and found a 55.9 cm ear (Table 1); although this author noted that it was possible to find ears up to 60 cm, he provided no evidence to support this asseveration. Wellhausen *et al*. (1951) characterized the Jala landrace in Celaya, Guanajuato, and Chapingo, State of Mexico. In that study, perhaps because environmental conditions were different from those prevailing in the Jala Valley at that time, the Jala landrace did not express its distinctive character to the expected extent. This explains the shorter average ear length reported in this work, which is much lower than the average reported by Kempton (Table 1). In contrast, although the average length of the most representative ears of the Jala landrace harvested in the Jala Valley in 2012 and 2023 were lower on average than the values reported by Kempton (1924) and Wellhausen *et al*. (1951), the maximum lengths significantly exceeded the average reported by Wellhausen *et al*. (1951), but were lower than the maximum ear length reported by Kempton (1924) (Table 1). It is worth adding that, as a result of the systematic maize collection initiated in the fall of 1943 as part of a project funded by the Rockefeller Foundation (Wellhausen *et al*., 1951), and of more recent collections made by other researchers, CIMMYT's germplasm bank

Revista Bio ciencias
ISSN 2007-3380

houses 15 collections considered original to the Jala landrace and five racial complexes obtained in the states of Nayarit and Jalisco between 1944 and 1988. These materials were evaluated in Jala in 1999, and it was observed that, in most cases, the phenotypic expression of the ears did not correspond to what farmers in the region consider as wet maize (Jala landrace), and did not display the distinctive characteristic of outstanding length (Hernández-Guzmán, 2007). Hence the importance of implementing *in-situ* conservation strategies for this and other plant genetic resources of interest.

Table 1. Distinctive ear characteristics of the Jala landrace expressed in different time and recording condition.

Variable	Kempton (1924)	Wellhausen *et al*. (1951)	Isolated *in-situ* lots[1]	
			2012[2]	2023[3]
Average ear length (cm)	50.8	30.5	27.5	27.9
Maximum ear length (cm)	55.9	-	35.2	39.8
Ear diameter (cm)	7.3	5.9	6.0	5.0
Number of seeds per ear	700-1000	-	360-912	228-756
Weight per seed (g)	0.6	-	0.51	0.51
Number of ear rows	12	14.7	12.3	11.1

[1]Established in the Jala Valley, Nayarit, in the specified year, [2]Sample of 295 ears, [3]Sample of 219 ears.

The methodology based on the phenotypic selection ears of the Jala landrace produced *in-situ*, the formation of balanced compounds from 200-300 representative ears of the landrace, genetic recombination through the *in-situ* establishment of these compounds in isolated lots, the repetition of the selection process to ensure the necessary continuity in subsequent cycles, and the free distribution of seed derived from these lots for use by Jala landrace maize producers interested in its use, is a methodological practice that the Colegio de Postgraduados implemented from 1999 to 2024, in non-consecutive homologous agricultural cycles. It is suggested that, to the extent technically and economically possible, this strategy be adopted as a way to conserve not only the genetic diversity of this and other endangered maize landraces, but also to preserve the one´s own existence of these landraces. This may be complementary to the suggestions made by Camacho-Villa *et al*. (2024).

Over time, there was significant variation in ear diameter, number of seeds per ear, and weight per seed unit (Table 1). For these three attributes, the values reported by Kempton (1924) were higher than those reported by Wellhausen *et al*. (1951) and those derived from the *in-situ* conservation project that the Colegio de Postgraduados is carrying out in the region. Although there is no way to demonstrate this with materials of the Jala landrace so contrasting in year of origin, the superiority of the values reported by Kempton (1924) for these attributes may be explained

Revista Bio ciencias
ISSN 2007-3380

by the fact that, when Kempton visited Jala, the prevailing conditions in the valley (fertile soils, abundant and well-distributed rainfall, and good residual moisture) allowed the ear, a demanding organ, to receive an adequate supply of photosynthates. This is explained by the occurrence of a high net photosynthetic rate and remobilization of photoassimilates from the source tissues to the demand organ (Smith *et al*., 2018). The abundant foliage produced by the Jala landrace can eventually maintain a photosynthetic rate efficiently and for a longer time, leading to a satisfactory development of the ear and the seed, also favored by the long biological cycle of the crop (greater than seven months). According to producers, at present, environmental conditions are increasingly restrictive for the development of the Jala landrace, since the soils are considered to have less fertility, they have a lower capacity to retain moisture, there has been a reduction in plant height and the crop cycle over time, and it is possible that the sum of unfavorable natural factors influence to not allow the greatest magnitude of expression of distinctive characteristics of the Jala landrace.

Regarding the number of rows in the ear, Kempton (1924) reported an average of 12 (Table 1). Currently, ears with a phenotype similar to the Jala landrace are found, with 10-18 rows. This is explained by the fact that, starting in the 1970s, improved maize varieties were introduced to the Jala Valley (Rice, 2004); varieties that have a high number of rows and that, eventually, through random pollination, are crossed, recombined, and increase the number of rows in the Jala landrace. According to Jala landrace maize producers, a number of rows between 12 and 14 is an important criterion when selecting ears of this maize landrace. This coincides with the arguments of Dr. Víctor Antonio Vidal Martínez, INIFAP Researcher (Personal Communication).

In this context, it is worth noting that producer José Ismael Elías Pérez, from the town of Coapan, is consistently participating in *in-situ* conservation work on Jala landrace maize. In 2023, on a plot located in Coapan, 6 km from Jala, the municipal capital, José Ismael produced a 50 cm long ear (Figure 1). This ear is the longest current specimen for which evidence exists, since Kempton's discovery in 1907. The ear presented defects in seed formation at its base, which is explained by the asynchrony between the appearance of receptive silks and the presence of fertile pollen, mainly from surrounding plants, given that, as an allogamous plant, maize requires cross-pollination. The rachis or cob shows empty spaces which, if pollination, fertilization, and development of these seeds had occurred, perhaps the ear would have exceeded 50 cm. This ear, with 12 rows and 660 seeds, is the closest to the phenotype described by Kempton (2024). Just for reference, in December 2008, at the initiative of the Colegio de Postgraduados, the first ear competition was held in Jala; the first-place winner presented a specimen that measured only 36 cm (Hernández-Guzmán *et al*., 2017).

Revista Bio ciencias
ISSN 2007-3380

Figure 1. Fifty-centimeter ear harvested in Coapan, Municipality of Jala, Nayarit, in November 2023, by José Ismael Elías Pérez.

Photograph taken by: J. Arahón Hernández Guzmán.

Corncob competition

Jala landrace maize is fundamental in the traditional fair of the town of Jala, as it allows the "World's Largest Corncob Contest" to be held. J. Carlos Octavio Carrillo Santana, Municipal President of Jala during the period 1981 to 1984, in an interview in 2012, commented "the idea of the contest arose to have an event within the traditional corncob fair that would consider the participation of maize producers." In this context, the first corncob contest took place on August 14, 1981, as a means to motivate producers to continue planting this maize (SAGARPA, 2014).

For the contest, a call for entries is issued, and wet maize or Jala landrace producers participate, after registering with the Rural Development Department of the City Council. On the day of the competition, producers bring corncob specimens with bracts (totomoxtle), selected from their plot. From 1981 to 2016, five corncobs per producer were required, and since 2017, only three are required, to reduce the time required to remove bracts from the corncobs in front of the expectant public. However, the findings of Hernández-Guzmán *et al*. (2017) also apply, in the sense that corncobs carry genetic information for length, and over time, this action can contribute to a reduction in the size of the ear and corncob, since, after the event, these corncobs are either boiled for consumption or discarded.

Following an invitation issued by the municipal authority, the Qualifying Jury is formed, made up of researchers from public institutions such as the Secretariat of Agriculture and Rural Development, the Autonomous University of Nayarit, the National Institute of Forestry, Agricultural and Livestock Research, the International Maize and Wheat Improvement Center, and Colegio de Postgraduados. Each producer is called to the stage, bracts are removed from their corncobs, and the length of each specimen is measured and recorded. Length considers the distance from the first kernel at the base to the last kernel at the tip of the corncob, in a representative row. Corncobs must at least be in a milky state; those very tender are discarded. The longest corncob

Revista Bio ciencias
ISSN 2007-3380

per participant is identified, and a prize is awarded to those who present the first three longest corncobs. The winning producers receive financial incentives, and their specimens are exposed to the audience. The winners proudly display their corncob specimens, which earned them recognition from the public, authorities, and the media. In 2023, the longest corncob in the history of the competitions that began in 1981 was recorded, it was 49 cm and was presented by Oscar Saúl Elías Pérez. Jesús Grande Ventura won first place from 1985 to 1989 (Listman & Pineda, 1992); however, the lengths of the corncobs harvested by that producer during those years were not reported.

Based on the history of corncob contests and interviews with those who grew or still grow Jala landrace maize, we identified producers recognized in the region as key protagonists in this event and also as maintainers of this maize. They were or still are the main source of seed for other producers in the municipality. José Antioco Elías Partida (personal communication) participated in the corncob contest continuously from the beginning in 1981 until he died in 2017. And on numerous occasions (the complete record is not available), he obtained one of the first three places. Now his sons, Oscar Saúl Elías Pérez and José Ismael Elías Pérez, continue that legacy, along with his grandson, Izahir Emmanuel Elías Delgado. In this generational shift in the field of *in-situ* conservation of Jala landrace maize, they were the winners of the first three places in the 2023 contest (Figure 2). Generational change, particularly family participation, is essential in the *in-situ* conservation strategy, as stated by Camacho-Villa ***et al***. (2024).

Table 2 lists the winners from 1997 to 2024, except for the period from 2001 to 2004, as records are unavailable for those years. Maximum corncob lengths ranged from 33.7 to 49.0 cm, with an average of 41 cm. These corncob lengths, if left to mature until the ear, would show a significant reduction attributed to the process of moisture loss from the cob and grain, so the final size of these specimens would be smaller on the ear. It is not possible to evaluate the above because, once the contest is over, the corncobs are discarded or boiled for consumption (Hernández-Guzmán ***et al***., 2017). Preserving them so that the seed continues its development process until maturity is also not possible, as the conditions do not exist, especially because the participating corncobs are detached from the mother plant at a stage that is still far from physiological maturity.

Revista Bio ciencias
ISSN 2007-3380

Figure 2. Winners of the first three places in the contest held in Jala, Nayarit, Mexico, on August 15, 2023.

Photograph description: From left to right, Izahir Emanuel Elías Delgado, Oscar Saúl Elías Pérez, and José Ismael Elías Pérez; grandson and sons of José Antioco Elías Partida. **Photograph taken by:** Arahón Hernández Ortega.

Figure 3 is a graphical representation of the data in Table 2. It includes maximum ear length values from 1907 to 2023. Based on this, there is a clear decrease in ear length over time; unfortunately, there are no records for ear length over this long period. In the case of corncob length, the annual variation shown by the maximum length of winning corncobs in the different contests is noteworthy, with a non-consistent trend, but in general, these lengths have been maintained throughout the evaluated period. With this, it is possible to affirm that, in some way, the corncob contest allows, if not to improve, at least to preserve the distinctive character of Jala landrace maize, and most importantly, allows its cultivation and, thus, its *in-situ* conservation. Prior to each agricultural cycle, in the opinion of producers, they emphasize selecting the longest ears with characteristics they believe correspond to the Jala landrace. Their primary motivation is the production of the corncob in the following agricultural cycle that will allow them to be protagonists in the popular corncob contest, with the expectation of winning first place, the prize associated with that distinction, and the recognition of the audience. However, it is worth noting that there is no individual monitoring of the plots or lots where the corncobs that will be presented in the competition are produced. Therefore, each producer is free to manipulate controllable production factors, which may favor the environmental effect and genotype-environment interaction rather

Revista Bio ciencias
ISSN 2007-3380

than the genetic component for length. Even so, with some variation, the winning specimens have fluctuated within a narrow numerical range.

Table 2. Producers who won first place in different contests, locality of origin, and corncob length.

Year	Winning producers	Locality	Corncob length (cm)
1997	Elías Zúñiga Altamirano	Jala	41.0
1998	José Antioco Elías Partida	Coapan	39.5
1999	José Antioco Elías Partida	Coapan	38.0
2000	Jesús Rodríguez Chávez	Jala	35.0
2005	José Luís Rodríguez López	Jala	45.0
2006	Efrén González Partida	Jala	33.7
2007	José Luís Rodríguez López	Jala	36.0
2008	José Antioco Elías Partida	Coapan	41.0
2009	Mauricio Z. S.	Jala	39.0
2010	José Antioco Elías Partida	Coapan	36.0
2011	Mauricio Z. S.	Jala	40.0
2012	José Antioco Elías Partida	Coapan	38.0
2013	José Antioco Elías Partida	Coapan	39.0
2014	José Antioco Elías Partida	Coapan	43.0
2015	Domingo Fránquez Flores	Coapan	44.0
2016	J. Carmen Gómez Rodríguez	Jala	45.0
2017	J. Carmen Gómez Rodríguez	Jala	48.5
2018	José Manuel Gómez Rodríguez	Jomulco	43.0
2019	Jesús Nazario Elías Moctezuma	Coapan	43.0
2020	Jesús Nazario Elías Moctezuma	Coapan	39.5
2021	Antonio Aquino Preciado	Jala	43.0
2022	José Manuel Gómez Rodríguez	Jomulco	43.0
2023	Óscar Saúl Elías Pérez	Coapan	49.0
2024	José Manuel Gómez Rodríguez	Jomulco	45.0

Revista Bio ciencias
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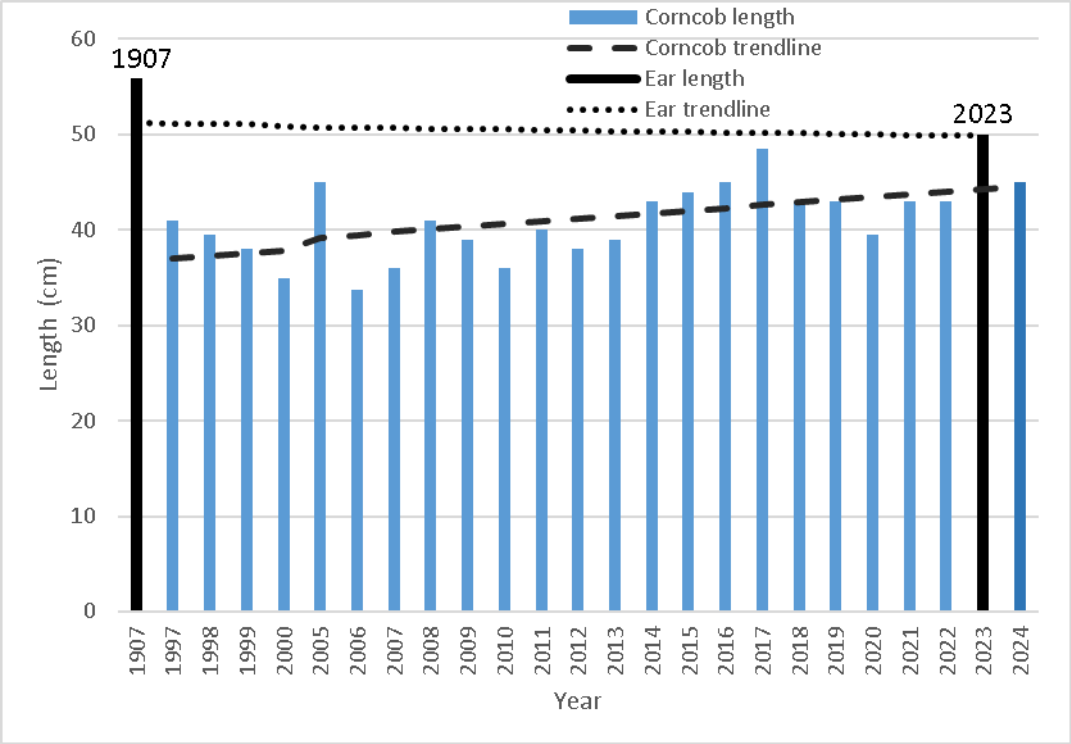

Figure 3. Variation over time of maximum ear and corncob lengths, in Jala, Nayarit, Mexico.

When comparing the maximum corncob (49 cm) and ear (50 cm) length, both recorded in 2023, with the 55.9 cm of ear mentioned by Kempton (1924), it is evident that there is a reduction in the lengths that Jala landrace maize currently expresses, without this reduction being drastic. Hernández-Guzmán *et al*. (2017) state that this reduction can be explained because, for the corncob contest, producers cut the largest specimens, which carry genes for length, but since they are harvested immature, they do not contribute to seed sources for future plantings. They add that a serious problem is that few producers still have pure sources of seed of this maize landrace, and often, few also sell or share their own seed so that other local producers can grow the Jala landrace. As this process is repeated over time, a loss in the distinctive character of the Jala landrace is to be expected; and above all, as stated by Ocampo-Giraldo *et al*. (2020), in the loss of genetic diversity.

Revista Bio ciencias
ISSN 2007-3380

The corncob contest and the conservation of Jala landrace maize

How much area is used for growing Jala landrace maize?

Based on the analysis of information collected through the questionnaire applied to 24 producers, the agricultural area used to grow Jala landrace maize varies from 0.2 to 1.5 ha. 100% of those interviewed agreed that, in the last 15 years, the area devoted to Jala landrace maize has been significantly reduced due to less and uneven rainfall, which limits proper development. They recognize the introduction of other crops and the destruction of the region's soils for road construction as critical factors. Hernández-Guzmán *et al*. (2017) point out that Jala landrace maize is cultivated by a few farmers, in increasingly reduced areas. These authors mention that among the risk factors for its *in-situ* conservation is the introduction of improved maize varieties; the planting of peanuts, jamaica, tobacco, and sugarcane; the depletion of residual soil moisture; the construction of housing, educational centers, greenhouses, packing plants, and highways. In this sense, as of 2020, the planting of blue agave has spread in the region, occupying a significant portion of the fertile soils previously used for maize. Jala landrace maize has been rapidly replaced by hybrids and other improved varieties that are more productive and better adapted to changing local uses. Perhaps this landrace could continue to be cultivated for some time because of its unique role in the annual corncob fair (Listman & Pineda, 1992). Given this scenario, in which the conservation of the Jala landrace is threatened by various factors (Montes-Hernández *et al*., 2014), it is advisable to initiate a genetic improvement program, which, among other approaches, could include its tolerance to environmental stress, as well as a reduction in its biological cycle and plant height, while maintaining ear length.

In 2024, following a field trip conducted by the first author of this contribution in the localities of Jala, Jomulco, and Coapan, in the municipality of Jala, it was estimated that the area planted with Jala landrace maize was less than 10 hectares, including small lots or backyards planted by some producers to guarantee their participation in the corncob contest. This places this type of maize in a critical situation. It is pertinent to mention the very profound and predictive phrase that Jesús Rodríguez Chávez, a native of Jala, said on June 18, 1999, in an interview: "We are losing a treasure."

On what date do you plant, and what is the origin of the seed?

Ninety-five percent of producers sow in the first 10 days of April, and only 5% in the last days of March. Ninety-three percent use seed selected from their own harvest, and 7% buy it. It is noteworthy that, of those who use their own seed, 100% practice home selection. In general, they harvest ears with bracts, transport them home, and remove the bracts for subsequent marketing, since, due to their length, these acquire high value in the local market. In cases where the ears are stripped at the plot, they take the harvest home and, at the appropriate time, select ears for seed. As selection criteria, 100% agreed in giving greater importance to the length of the ear, then to the number of rows (12 and 14), and on the overall appearance of the seed. In this sense, in the same interview with Jesús Rodríguez Chávez in 1999, he stated: "I carry the harvest and bring it

Revista Bio ciencias
ISSN 2007-3380

all at home. As I husk the ears, I separate all those measuring between 40 and 45 cm to use as seed." Jesús Rodríguez, who passed away on December 20, 2001, at the age of 76, was one of the main maintainers of the Jala landrace maize and, for a long time, one of the main distributors of seed for other producers.

What are the reasons for planting Jala landrace maize?

Ninety-one percent plant to have corncobs and to participate in the traditional contest. Other reasons include enjoying quality corncobs with family and friends, selling corncobs, using the grain to make tortillas, pozole, and the traditional "gorditas de horno" (oven-baked gorditas), as well as selling the husks (bracts) for tamales. Nine percent said that they plant so they can sell it as corncobs or as fodder, because the price they are paid is considerable. Valdivia-Bernal *et al*. (2010) stated that consumption of corncob and for the preparation of pozole are the main uses of Jala landrace maize. Regarding maize, there are natural, geographical, anthropological, social, and cultural elements that allow it to have such a wide variety of uses, to constitute the basis of the diet of many families and to be a fundamental part of Mexican traditions and customs (Cuevas, 2014).

What disadvantages does Jala landrace maize have that could put its cultivation at risk?

A hundred percent agreed that the soils of the Jala Valley are increasingly less fertile and dry, which makes that the Jala landrace maize, with a cycle of more than seven months, have problems developing. A disadvantage that stands out is the susceptibility to lodging, which is explained by the great height of the plant and the ear position, combined with the sandy texture of the soils, which also limits a good root anchorage. Other disadvantages mentioned are the low grain yields (less than 3.5 t ha^{-1}), susceptibility to attack by field and storage pests, and the increasingly frequent theft of corncobs. As stated by Montes-Hernández *et al*. (2014), Jala landrace has different desirable attributes, but there are factors attributable to the landrace itself, as well as natural and human factors that put its conservation at risk.

Do you think the corncob contest contributes to the conservation of the Jala landrace maize?

Only 5.5% stated that the corncob contest does not help to conserve Jala landrace maize; the remaining 94.5% stated that it does contribute. Of the total number of those who stated that the contest contributes to the conservation of this maize, 89% believe that if the corncob fair and within it the corncob contest did not exist, it is very likely that the *in-situ* planting of this maize would have already disappeared. But it is required more than the fair and the contest to guarantee the conservation of Jala landrace maize. The few producers who still cultivate it are successfully doing their part. What is lacking is the integration of institutions and authorities with a clear mission and coordinated actions toward that common goal. In this context, Ocampo-Giraldo *et al*. (2020) suggest applying a dynamic conservation strategy, which, in addition to combining *ex-situ* and *in-situ* conservation methods, its socioeconomic utility is emphasized, sustainable agriculture is

Revista Bio ciencias
ISSN 2007-3380

explored, and traditional and cultural knowledge is involved, as a heritage that materializes in the management of the cultivation of local varieties. Camacho-Villa *et al*. (2024) argued that “the development of comprehensive strategies that involve informal (such as the family) and formal (different levels of government) social institutions, under a national, state, and local legal framework for maize as cultural heritage, becomes critical for the *in-situ* conservation of Jala landrace maize and other maize landraces in Mexico.”

As a final consideration, to take advantage of the experience generated by the corncob contest and integrate other elements linked to the Jala landrace maize, it is important to highlight first that the deep-rootedness of the corncob contest within the traditional Jala community fair makes it a fundamental and immovable event; and that this event, due to the local, scientific, and media expectation that it generates, is only feasible to carry it out with the maize landrace that produces the longest corncob among all the known landraces worldwide, which its threatened in its existence. Given this, it is suggested: a) to convene and implement information and analysis meetings with the participation of producers of the Jala landrace maize, agricultural sector authorities from different levels of government and researchers from academic institutions, in order to generate collective awareness of the importance of acting in favor of the conservation of this maize landrace; b) advise producers to carry out practices focused on soil improvement for moisture capture and retention, as well as for the production of Jala landrace maize with pre-established quality standards (genetic, physiological, physical and sanitary), favoring agroecological management of the crop; c) manage and commit economic incentives for those producers who cultivate the Jala landrace and who also participate in the corncob contest; d) train producers in the application of maize selection practices in the field, complemented by barn selection, the formation of balanced compounds as a source of seed for their own future plantings and safe seed storage; e) encourage the safeguarding of each producer’s seed through community seed banks or national germplasm banks; f) train producers to stratify their plot from planting, in order to allocate part of it to seed selection and the other part for marketing; g) document, disseminate and apply those opportunities that, derived from the multiple quality attributes of the Jala landrace, allow adding value to its use, such as the organization of producers so that, within the framework of the local fair, they may obtain tangible benefits through the commercialization of corncobs as the main attraction of this traditional event; and h) apply plant breeding schemes to develop variants of the Jala landrace that respond better to current agroclimatic conditions, with an emphasis on maintaining ear length, as well as taking advantage of the potential of the Jala landrace to improve other types of maize with greater adaptation and productive potential.

Conclusions

The drastic decrease in the current area cultivated with Jala landrace maize in its place of origin and main distribution threatens its *in-situ* conservation and puts this plant genetic resource, unique in the world for its ear and corncob length, at high risk of loss.

Revista Bio ciencias
ISSN 2007-3380

The corncob contest is essential for the *in-situ* conservation of Jala landrace maize; however, for this event to have a greater impact, it must integrate a series of institutional, technical, scientific, economic, and producer organization elements.

Based on the existing reference information related to the maximum ear length of Jala landrace maize produced in 1907 (55.9 cm) compared to that obtained in 2023 (50 cm), the reduction in this distinctive characteristic of the Jala landrace maize is minor.

The corncob contest has not contributed to increasing ear length, but evidence suggests the possibility that the event at least contributes to preserving the expression of that distinctive character of the Jala landrace, derived from the selection process that producers implement each agricultural cycle to generate their seed source and thus participate in the corncob contest.

The use of the Jala landrace is limited due to its high adaptation to its microenvironment, its great plant height and ultra-late cycle; however, considering the range of favorable attributes it possesses, it can and should be an interesting and important option to improve other maize with greater adaptation, as well as for the development of Jala landrace variants with a better response to current agroclimatic conditions.

Author's contribution

Work conceptualization, JAHG; methodology development, JAHG, EBR; software management, JAHG, EBR, EOT; experimental validation, JAHG, EBR; results analysis, JAHG, EBR, ORTG; data management, JAHG, EBR; manuscript writing and preparation, JAHG, EBR, PAL, AGM, JdeDGR, EOT, HLS, ORTG; drafting, revising, and editing, JAHG, EBR, PAL, AGM, JdeDGR, EOT, HLS, ORTG; project manager, JAHG; fund acquisition, JAHG, EBR, PAL, AGM, JdeDGR, EOT, HLS, ORTG.

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Revista Bio ciencias
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Conflict of Interest

The authors declare that they have no conflicts of interest.

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