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Assessment of the crop basket around the Egyptian Nile River; Eastern North Africa

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A R T I C L E   I N F O

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A B S T R A C T

This assessment tends to evaluate the Egyptian crop basket around the Nile River, with a focus on their introduction history. A framework of growth forms, flowering time, sex forms, cultivation duration, propagation methods, economic values, and ecological benefits was used. A side from assessing were global phyto-geographic regions, continental distribution, and biomes.

Twenty-four field visits were conducted covering the study area (March 2021 - March 2022) to verify collected data from the Egyptian Ministry of Agriculture, and checking the herbarium of Agricultural Museum, Cairo (CAIM). One hundred and ninety-one crops were recorded, of them 170 crops, belonging 101 genera and 45 families, are currently surveyed, while 21 crops are considered a gap, belonging 7 families and 19 genera. The most evaluated family was Fabaceae, while Citrus was the most evaluated genus. Herbaceous plants were the most recorded growth form (66.5 %). Most crops were bisexual, propagated by seeds, and grown in winter (43.5 %). Their flowering activity gradually increases from December reaching a peak in June.

Most crops (48.2 %) return to the Pharaonic era, e.g., Aloe vera and Portulaca oleracea. The majority of crops evaluated as foods (80.7 %) and humidity tolerant species (56 %). The Mediterranean and Saharan-Arabian regions were the most represented (42.9 %). Most crops originated in Africa, then Asia. Temperate deciduous forest and subtropical evergreen forest were the major biomes. As the majority of the Egyptian crops return to the Pharaonic era, indicating the relative stability of the Egyptian climate over last years.

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1. Introduction

Egypt's agricultural land is limited to the Nile Valley and delta, with a few oases and arable land in Sinai. The total cultivated area is 7.2 million acres (1 acre equals 0.42 ha), accounting for only 3 % of the total land area. Except for some rain-fed areas on the Mediterranean coast, the entire crop area is irrigated. In addition, 900 000 acres of newly reclaimed land have been added to the agricultural area over the last four decades. The landholdings are dispersed, with farm units averaging in size about 2.5 acres. The total area cropped annually is approximately 11.5 million acres, representing a cropping ratio of approximately 2:1 (https://www.fao.org/3/v9978e/v9978e0e.htm).

Egypt, is in North Africa across temperate grassland, desert and semi-desert biomes, has an arid climate, with annual average rainfall ranging from 60 to 190 mm along the Mediterranean coast to 25 to 60 mm in the Nile delta and less than 25 mm in upper Egypt and surrounding areas. The weather is generally very consistent, with plenty of sunshine. Furthermore, the Nile is an exceptional source of water, and the soil near the Nile is generally of high quality (Lomolino et al., 2017), https://weather-and-climate.com and https://www.fao.org/3/v9978e/v9978e0e.htm. In the last decade, Egypt's total agricultural crop production has increased by >20 %. During the same time period, the rate of population growth has been slightly larger than the rate of crop production growth (https://www.fao.org/3/v9978e/v9978e0e.htm).

Cultivated plants are frequently planted in gardens or crop fields to satisfy human desires The Egyptians from the pharaonic era till now not only cultivated their required crops in fields, but also ornamental plants for their numerous benefits (e.g., decoration, wind-breaking, fruit and flower production, use in traditional
industry or shading and riverbank erosion control) in gardens, which were typically built in palace or house squares or established terraces on the banks of the river or its branches. In addition to medicinal and aromatic plants for folk meditation and manufacture of drugs (Ammar, 2021; Ammar et al., 2020; Ahmed et al., 2020; Manniche, 2006).

Hence, this assessment will discuss the crop basket assessment around the Egyptian Nile River; Nile Delta, Nile Fayium, and Nile Valley. In addition to, highlighting on floristic and botanical characters of the assessed crop species. Furthermore, an evaluation of historical era for the introduction of these crops to Egypt, in addition to their economic values and ecological benefits. Likewise, geographic overview is assessed such as global phytogeography regions, continental distribution and world biomes.

2. Material and methods

2.1. Study area

Egypt is located in northeastern Africa, with the Egyptian Nile region spanning temperate grassland, desert, and semi-desert biomes, according to the world biome map (Lomolino et al. 2017), with a length of about 1520 km (23 percent of the total length of the river), and housing an estimated population of 80 million people. The Nile Region in Egypt is made up of three parts: The Nile Delta, the Nile Fayium, and the Nile Valley. The Nile Delta is part of the Egyptian Mediterranean coast and stretches approximately 240 km from Alexandria at Abu Quir in the west to Port Said in the east; the Nile Fayium is a depression below the sea level formed by wind erosion 1.8 million years ago and covering approximately 12,000 km²; and the Nile Valley stretches approximately 800 km from Aswan to the outskirts of Cairo (El-Shabrawy and Dumont, 2009; Dumont, 2018). The Nile region of Egypt is divided into 20 governorates, each with approximately 185 administrative centers (Fig. 1).

The Egyptian climate ranges from arid to hyper-arid, with the northern part of the Nile Delta classified as arid and the Nile Valley and southern part of the Nile Delta classified as hyper-arid. From 2012 to 2018, annual rainfall ranged between 80 and 200 mm year⁻¹ (https://power.larc.nasa.gov/). The highest precipitation areas are found along the Mediterranean coast (e.g., around Alexandria).Summer’s hot, dry season lasts from May to October (https://weather-and-climate.com).

2.2. Raw data collection

Raw data were collected through a performed questionnaire about the cultivated crops in centres of each governorate by visiting the agricultural management in each governorate of the studied area. Then these dates were verified via the Egyptian annual agricultural newspapers that were publicized by the Ministry of Agriculture and Reclamation from 2011 to 2021 for 185 centres. In addition, 24 field visits were performed covering the study area (March 2021 - March 2022) to verify the collected data. In addition, checking herbarium sheets of Egyptian crops in the herbarium of the Agricultural Museum, Cairo (CAIM).

2.3. Floristic analysis and botanical characters

Crops were identified and their accepted names were verified by the author. The identification of some species was revised according to their kept herbaceous sheets in Agricultural Museum Herbarium (CAIM). Growth form, flowering times and sex forms of the surveyed species were determined in the field. The main detected sex forms are bisexual, unisexual (monoecious and dioecious) or polygamous (Shaltout et al., 2010). Flowering times represents the season of the flowering activity of each surveyed crop, and then these parameters were verified by these references (Ammar, 2015; Ahmed et al., 2020; Ammar, 2021; El-Beheiry et al., 2015). There were main four cultivation habitats of the studied crops regarding to agricultural duration: winter crop fields (yield at winter months from December to February), summer crop fields (yield at summer months from June to August), late summer or late winter crop fields (yield at spring months from March to May or Autumn months from September to November) and orchards (fruit or ornamental perennial trees). Crops propagated sexually by seeds, but they propagated asexually by one or more of these 10 methods: division (stolons and offsets), spores, plantlets, separation (bulbils, bulbs, suckers and corms), cutting, air layering, grafting, rhizomes, tissue culture and budding. Propagation methods of the surveyed species were identified and gathered by asking farmers and agricultural engineers, then verified by these reference: (Kumar, 2011; Ammar, 2015; https://resourcecentral.org/plant-propagation-methods/) and (https://www.mastergardenproducts.com).

2.4. Historical view

Ten era categories of introduction of crops to Egypt: Pharonic, Ancient Greek, Ptolemaic, Romanic, Islamic, in addition to Mohamed Ali Family period that divided into 3 intervals; 1800s-1850s, 1850s-1900s and 1900s-1950s. Also, Republic period which divided into 2 eras (1950s-2000s) and (>2000s) (Ammar, 2021). These eras are detected from references in Egyptian libraries such as the libraries of the Agriculture Museum in Cairo and the Min-
istry of Agriculture and Reclamation (Delchevalerie, 1871; Bedevian, 1935; Mosleeh, 1942; Täckholm and Drar, 1950; Nazer, 1968; Täckholm and Drar, 1954; Mareey, 1970; El-Shaieb and Gerad, 1978; Khatab, 1979; Hagras, 1996; Ministry of Agriculture and Land Reclamation, 2004; Manniche, 2006); and also from old plant sheets in the herbarium of the Agricultural Museum in Dokki, Cairo (CAIM) of pioneer herbalists such as Drar and Khattab, Sha-betai, Simpson, Takhlima.

2.5. Economic values and Ecological benefits

Economic values are ordered into 6 key categories according to behavior of common Egyptians: food, medicine, decoration, grazing timber and others (e.g., fuel, industry, historical values and scientific studies). Fourteen ecological benefits were defined: humidity tolerant, cold tolerant, drought tolerant, shade source, heat tolerant, nitrogen fixers, animal tolerant, resistant to insects and pests, salinity tolerant, wind breakers, light tolerant, pH maintainers, sand accumulators and Air purifications. The checked references were (Makins et al., 1948; Boulos and El–Hadidi, 1994; Simpson and Ogorzaly, 1995; El–Hadidi, 1998; Burnie et al., 2004; Diwan et al., 2004; Shaltout and Ahmed, 2012; Shaltout and Ahmed, 2012; Ammar and Shaltout, 2013; El–Beheiry et al., 2015; Ammar, 2015; Ammar et al., 2020; Ammar, 2021), web site of The Food and Agriculture Organization of the United Nations (https://www.fao.org/faostat/en/#data), World Agricultural Production 2021 (https://www.fas.usda.gov/data/world-agricultural-production).

2.6. Global phyto-geographic regions, continental distribution and biomes

Crop flora was assessed according to Takhtajan’s system (1986) which divided the world into 35 biogeographic regions, world regions for the endemism of plant, based on the distribution of land plants (Lücking, 2003; Lomolino et al., 2017). Also, the crop distribution was evaluated in the 6 world continents; Asia, Africa, Europe, Australia and North America and South America as the crop origin (Lomolino et al., 2017). Crops were evaluated in relation to their biomes, the classification of the natural vegetation groups of the world according to the distribution of climatic regions and soil types. Biomes were classified into 9 regions; arctic tundra and ice, boreal forest, temperate deciduous forest and sub-tropical evergreen forest, temperate grasslands, temperate rainforest, desert and semi desert, tropical deciduous forest and savanna, tropical rainforest and alpine tundra (Lomolino et al., 2017).

3. Results

3.1. Floristic analysis and botanical characters

One hundred and ninety-one crop species, sub-species and varieties were recorded, from them 170 species were currently examined by the author, while 21 species were considered as a historical gap belonged to 7 families and 19 genera, they were found only as herbarium sheets in Herbarium of Agricultural Museum in Cairo (CAIM) or historical literatures (Table 1). The 170 crop species were surveyed, belonging to 101 genera and 45 families were documented in 185 field centers along the Nile River. The most represented families were Fabaceae (19 species and sub-species of the total), followed by Poaceae (18 species and sub-species). The most recorded genera are Citrus (7 species and sub-species of the total), followed by Brassica (6 species and sub-species) (Fig. 2a and b). The most recorded growth forms are herbaceous plants (113 species = 66.5 % of the total species), followed by trees-shrubs (39 species = 22.9 %). Agricultural habitats; winter crop field (74 species = 43.5 % from the total recorded crops), summer crop fields (58 species = 34.1 %), late summer or late winter crop fields (41 species = 66.5 % of the total species), followed by trees-shrubs (16 species = 9.6 %), then the period between 1850s and 1900s (1 species = 0.6 %) (Appendix).

Propagation methods are detected to only 167 recorded crop species. Crops were propagated by two ways: sexually by seeds (144 species of the total = 86.2 %), and asexually cutting (23 = 13.8 %). Rhizomes (11 = 6.6 %), offsets (10 = 6 %), grafting (8 = 4.8 %), bulbs (5 = 3 %), suckers, air-layering and corms (2.4 %), while each of buds, spores and stolons are represented by one species (0.6 %) (Appendix).

3.2. Historical view

One hundred sixty-six crop species had extracted date of introduction to cultivate in Nile Region, Egypt from other countries via previous literatures and historical herbarium sheets (98.8 % of the total recorded species). There was a highest record of the Egyptian crop plants’ age in the Pharaonic era (80 species = 48.2 % of the recorded species), while there was a slight crop plant introduction through the Ancient Greek civilization (7 species and sub-species), the Ptolemaic era (3 species and sub-species) and the Islamic era (6). There was a slightly increasing of plant introduction through the start of the era of Mohamed Ali Family; from 1800s to 1850s (16 species = 9.6 %), then the period between 1850s and 1900s

| Table 1 |
| --- |
| Twenty-one crop species were recorded as historical gap; they were found only as herbarium sheets in Herbarium of Agricultural Museum in Cairo (CAIM) or historical literatures. |

| Family | Genus | Species, sub-species or variety |
| --- | --- | --- |
| Apiaceae Lindl. | Arracacia | Arracacia xanthorrhiza Bancr. |
| (alt. Umbelliferae) | Bupleurum | Bupleurum semicompositum L. |
| Fabaceae Lindl. | Alhagi | Alhagi graecorum Boiss. |
| (alt. Leguminosae A. Juss.) | Indigofera | Indigofera macroacaulis Guill. & Perr. |
| Fabaceae Lindl. | Vigna | Vigna mungo (L.) Bepper |
| (alt. Labiatae) | Mentha | Mentha longifolia (L.) sub sp. longifolia |
| Lamiaceae | Origanum | Origanum vulgare L. |
| Martynov | Mentha | Mentha longifolia (L.) sub sp. longifolia |
| Malvaceae Juss | Corchorus | Corchorus capsularis L. |
| (alt. Labiatae) | Gossypium | Gossypium arboreum L. |
| Poaceae Barnhart | Sorghum | Sorghum virgatum (Hack.) Stapf. |
| (alt. Gramineae) | Zea | Zea luxurians (Dumerc & Asch.) R.M. Bean |
| Rosaceae A. Juss. | Rosa | Rosa clinoiphylia Thory |

The most recorded growth forms are herbaceous plants (113 species = 66.5 % of the total species), followed by trees-shrubs (39 species = 22.9 %). Agricultural habitats; winter crop field (74 species = 43.5 % from the total recorded crops), summer crop fields (58 species = 34.1 %), late summer or late winter crop fields (41 species = 66.5 % of the total species), followed by trees-shrubs (16 species = 9.6 %), then the period between 1850s and 1900s (1 species = 0.6 %) (Appendix).

Some plants reproduce also asexually by spores. These recorded crop species are mainly bisexual (151 species = 88.8 % of the total), followed by monocious (14 = 8.2 %), while one species reproduce asexually by spores (0.6 %) (Appendix). There is an increase in the flowering activity of the recorded species gradually from December (28.3 % of the total species) till reaching a maximum value in June (40.1 %). The period from March to June is characterized by the highest flowering activity, while the period from September to November is characterized by the lowest activity (Appendix).

Propagation methods are detected to only 167 recorded crop species. Crops were propagated by two ways: sexually by seeds (144 species of the total = 86.2 %), and asexually cutting (23 = 13.8 %). Rhizomes (11 = 6.6 %), offsets (10 = 6 %), grafting (8 = 4.8 %), bulbs (5 = 3 %), suckers, air-layering and corms (2.4 %), while each of buds, spores and stolons are represented by one species (0.6 %) (Appendix).
(27 species = 16.3 %), followed by (19 species = 11.4 %) in the period between 1900s and 1950s. There was a slightly decreasing of the plant introducing via the modern era; (4 species = 2.4 %) in the period between 1950s and 2000s, and also (4 species = 2.4 %) via the period more than the year 2000 (Fig. 3, Appendix).

3.3. Economic values and Ecological benefits

The whole species in Nile region have at least one trait of the actual or potential economic values: 51 species have one use, 72 have 2 services, 33 have 3 services, 13 have 4 services and Annona cherimola has 5 services alone (Tables 1 and 2, Appendix). Recorded economic values are arranged as following: human food (137 species = 80.7 % of the total), medicinal purposes (78 = 45.9 %), decoration (58 = 34.1 %), and other uses (e.g., fat and oil industries, fuel and paintings, religious ceremonies, educational purposes, chemical industry) (57 = 33.5 %), grazing (12 = 7.1 %) and timber (9 = 5.3 %) (Table 2, Appendix).

One hundred fifty species (87.7 % of the total) have at least one trait of the actual or potential environmental services. Thirty-nine species had one service, 58 have 2 services, 46 have 3 services and Ziziphus spina-christi has five services alone (Tables 2 and 3, Appendix). Recorded environmental services are arranged as following: humidity tolerant (84 species = 56 % of the total), cold tolerant (75 = 50.0 %), drought tolerant (40 = 26.7 %), shade sources (37 = 24.7 %), heat tolerant

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**Fig. 2.** The most top families and genera of the recorded crop plants.
(29 = 19.3 %), nitrogen fixers (19 = 12.7 %), each of animal tolerant and resistant to pests and insects (10 = 6.7 %), salinity tolerant (7 = 4.7 %), wind breakers (2 = 1.3 %). In addition, pH maintainer and light tolerant are represented by *Matricaria chamomilla* alone, while *Ricinus communis* acts as sand accumulators and *Thymus vulgaris* makes air purification (0.7 % for each) (Table 2, Appendix).

### 3.4. Global phyto-geographic regions, continental distribution and biomes

About global phyto-geographic region; Mediterranean region and Saharan-Arabian region are the most represented (73 species = 42.9 %), then Sudano-Zambesian region (49 species = 28.2 %), while each of St. Helena and Ascension, Fernándezian, Subantarctic Islands and Neozeylandic regions is represented by one species only (0.6 %) (Table 4).

Nineteen species are endemic in one phytogeographic region (11.2 %), 42 species in two regions (24.7 %), 55 in three (32.4 %), 17 in four (10 %), 12 in five (7.1 %) and 25 in more than five regions (14.7 %) (Fig. 4).

As the continental distribution, 108 Egyptian crops were originated from Africa (63.5 %), 67 crops from Asia (39.7 %), 65 crops from Europe (38.2 %), 24 crops from South America (14.1 %), 22 from North America (12.9 %) and 8 from Australia (4.7 %). Eighty-eight species were originated from one continent (51.8 %), 48 species from two continents (28.2 %), 29 from 3 (17.1 %), 2 from 4 (1.2 %) and 3 from 5 (1.8 %) (Fig. 5a and b).

Regarding to biomes; 128 species are orginated in temperate deciduous forest and subtropical evergreen forest biomes, 119 species in temperate grasslands, 107 in desert and semi-desert, 87 in tropical rainforest, 70 in tropical deciduous forest and savanna, 40 in boreal forest, 28 in arctic tundra and ice, 24 in temperate rainforest and 25 in alpine tundra. Twenty-three species are originated in one biome (13.5 %), 26 in two biomes (15.3 %), 48 in three (28.2 %), 18 in four (10.6 %), 27 in five (15.9 %) and 27 in more than five biomes (15.9 %) (Fig. 6a and b).

### 4. Discussion

#### 4.1. Floristic analysis and botanical characters

One hundred and ninety-one crop species, sub-species and varieties have been recorded throughout the Egyptian Nile region, with 170 species (89.0 percent) currently under investigation, belonging to 101 genera and 45 families. Whereas 21 species (11.0 percent) belonged to 7 families and 19 genera, they were only found as herbarium sheets in the Herbarium of the Agricultural Museum in Cairo (CAIM) or in historical literatures. (Ammar, 2015; El-Beheiry et al., 2015) recorded only 173 crops in Egypt’s Nile Delta, belonging to 44 families and 99 genera, regardless of whether these crops were widely cultivated or not. The majority of the 22 crops evaluated as historical gaps are wild species that are still used as medicinal plants or for other purposes, but are not widely cultivated as crops, e.g., *Origanum vulgare* and *Mentha longifolia* sub sp. *longifolia*. Fabaceae was the most represented families (11.2 percent from the current recorded species), followed by following Poaceae (10.6 percent). Citrus was the most commonly recorded genus (4.1 percent), followed by *Brassica* (3.5 percent).

According to (Ammar, 2015; El-Beheiry et al., 2015), Poaceae had the highest value (12.7 percent of total species), followed by Fabaceae (12.1 percent), and Cucumis had the highest value (4.6 percent), followed by *Brassica* and *Citrus* (4.0 percent for each). Herbaceous plants have the most recorded growth forms (66.5 percent), followed by trees and shrubs (22.9 percent). This result agreed with (Ammar, 2015; El-Beheiry et al., 2015), who found that herbaceous plants were the most abundant (71.1 percent), followed by trees and shrubs (23.9 percent). Agricultural habitats include winter crop fields (43.5 percent of all crops recorded), followed by summer crop fields (34.1 percent). According to (Ammar, 2015; El-Beheiry et al., 2015), the majority of species grow in the winter (68 percent), followed by the summer (18 percent).

The majority of crops reproduce bisexually (88.8 percent of the total). The predominance of hermaphrodites is a common feature of the world’s floras (e.g. 92 percent of the British flora is hermaphrodites; Lewis D, 1941). The flowering activity of the recorded species gradually increases from December (28.3 percent of the total species) to a maximum value in June (40.1 percent). The frequency of flowering time in the Nile Delta gradually increases from March to May, with the lowest frequency occurring from June to November (Shaltout et al., 2010). According to (El-Beheiry et al., 2015), the percentage of flowering species radually increases from 24.8 percent in December to 44.6 percent in May. Crops were propagated sexually (86.2 percent) by seeds and asexually mostly by cutting (13.8 percent). The majority of flowering plants are propagated sexually through seeds, but some crops are propagated through

![Figure 3](image-url)
Table 2
Features of the recorded crop species in the Nile Region.

| Economic values | Agricultural habitats |
|-----------------|-----------------------|
| FD | DE, FD, ME, TI, OT |
| MD | DE, FD, ME |
| OT | DU, ME, FD, OT, ME |
| ME | FD, ME, OT |
| DT | DU, ME, FD, OT, ME |
| SS | DU, ME, FD, OT, ME |
| TI | DU, ME, FD, OT, ME |
| PH | DU, ME, FD, OT, ME |
| SA | DU, ME, FD, OT, ME |
| AP | DU, ME, FD, OT, ME |

Table 3
Crops offer multi-purpose economic values and ecological benefits; 15 multipurpose crops offer > 3 economic values, where FD: food, DE: decoration, MD: medicine, OT: other uses (e.g., Oil industries, paintings and timber). Six multi-purpose crops offer > 3 ecological benefits, where HT: humidity tolerant, CT: cold tolerant, DT: drought tolerant, NF: nitrogen fixers, PR: resistant to insects and pests, ST: salinity tolerant, WB: wind breakers, SA: sand accumulators and SS: Shade source.

| Crop species | Economic values | Ecological benefits |
|--------------|----------------|-------------------|
| Ammonia cherimola | DE, FD, ME, TI, OT | Lathyrus olereaceus | DT, HT, CT, NF |
| Carica papaya | DE, FD, OT, ME | Opuntia ficus-indica | DT, ST, HT |
| Citrus aurantifolia | DE, FD, OT, ME | Phoenix dactylifera | SS, HT, DT, TT |
| Cymbopogon citratus | DE, FD, OT, ME | Psism sativum subsp. brevipedunculata | NF |
| Mentha piperita | DE, FD, OT, ME | Psism sativum var. macaron | NF |
| Morus alba | DE, FD, OT, ME | Ricinus communis | WB, SA, SS, PR |
| Ocimum basilicum | DE, FD, OT | Ziziphus spina-christi | SS, ST, WB, DT |
| Origanum majorana | DE, FD, OT | ME |
| Salvia rosmarinus | DE, FD, OT | ME |
| Syzygium cumini | DE, FD, OT | ME |
| Vitis vinifera | DE, FD, OT, ME | ME |
| Ziziphus spina-christi | FD, DE, TI, OT | ME |

4.2. Historical view

About 97.6% of the current crops had extracted their date of introducing to the Egyptian Nile Region. There was a highest record of the Egyptian crop plants' age in the Pharaonic era (48.2% of the recorded species). Agriculture was the backbone of the ancient Egyptian economy and was essential to the lives of the people who lived there. Agricultural practises began in the Predynastic Period in Egypt (c. 6000 - c. 3150 BCE) in the Delta Region of northern Egypt and the fertile basin known as the Faiyum, but there is evidence of agricultural use and overuse of the land dating back to 8000 BCE. Egyptians have continued to cultivate the basic strategic crops in their daily lives since the pharaohs' era until now, but they have sought to preserve their genetic origins through the ages primarily for food insurance and feeding their animals, such as Triticum aestivum, Hordeum vulgare, and Sorghum bicolor. In addition to other economic uses such as cloth and texture production (e.g., Gossypium barbadense and Linum usitatissimum) and oil extraction (e.g., Phoenix dactylifera; Manniche, 2006). According to the findings of this study, the majority of the Egyptian crop basket dates back to the Pharaonic era, indicating the relative stability of the Egyptian climate over time. As a result, eradicating poverty and hunger in Egypt is not as difficult as it is in countries where environmental and behavioural conditions are changing. B.C., when the people of the Prophet Moses asked him to replace their food with beans, onions, garlic, cucumbers, wheat and vegetables, he said to them, “Go
down to Egypt, for you will have what you asked for” (The Holy Quran, Surat Al-Baqarah: 61) (https://quranenc.com/). Wheat has existed in Egypt since the time of the Pharaohs, and this is what was mentioned in the story of the Prophet Joseph, who asked the ruler of Egypt at the time to manage the wheat silos in Egypt, and called them the earth’s reservoirs. for their abundant production (The Holy Quran, Surat Yusuf: 55). Figs and olives are mentioned in the Noble Qur’an, and the figs we eat, and the olives we eat, but I swear by figs because they are food, fruits and medicines. It opens the pores of the liver and spleen, and it is the best and most valuable fruit, and indeed: (cuts hemorrhoids, and helps gout). Likewise, olives, because they are a fruit, a spice and a medicine from which the oil is pressed, and it is the important oils and fats for the people of some countries, and it is included in many medicines. He mentioned that they are in Mount Al-Tur in Sinai. Sinai is located in Egypt (The Holy Quran, Surat Al-Teen: 1 and 2). The olive tree; a tree that emerges from Mount Sinai, and a tree erected in turn over the gardens. Mount Sinai means Mount El-Tur in Sinai, Egypt (he Holy Quran, Surat Al-Mu’min

| Global phytogeographic regions | Region number | Species or variety | Percentage (%) |
|-------------------------------|---------------|--------------------|----------------|
| Circumboreal region           | 1             | 48                 | 28.2           |
| Eastern Asiatic region        | 2             | 19                 | 11.2           |
| North American Atlantic region| 3             | 8                  | 4.7            |
| Rocky Mountain region         | 4             | 7                  | 4.1            |
| Macaronesian region           | 5             | 8                  | 4.7            |
| Mediterraneaean region        | 6             | 73                 | 42.9           |
| Saharan-Arabian region        | 7             | 73                 | 42.9           |
| Irano-Turanian region         | 8             | 38                 | 22.4           |
| Madrian region                | 9             | 12                 | 7.1            |
| Guineo-Congolian region        | 10            | 14                 | 8.2            |
| Uzambara-Zululand region      | 11            | 7                  | 4.1            |
| Sudano-Zambesian region        | 12            | 49                 | 28.8           |
| Karoo-Namib region            | 13            | 8                  | 4.7            |
| St. Helena and Ascension region| 14            | 1                  | 0.6            |
| Madagascan region             | 15            | 10                 | 5.9            |
| Indian region                 | 16            | 45                 | 26.5           |
| Indochinese region            | 17            | 30                 | 17.6           |
| Malesian region               | 18            | 27                 | 15.9           |
| Fijian region                 | 19            | 9                  | 4.7            |
| Polynesian region              | 20            | 10                 | 5.9            |
| Hawaiian region               | 21            | 8                  | 4.7            |
| Neocaledonian region          | 22            | 2                  | 1.2            |
| Caribbean region               | 23            | 21                 | 12.4           |
| Guayana Highlands             | 24            | 12                 | 7.1            |
| Amazonian region              | 25            | 21                 | 12.4           |
| Brazilian region              | 26            | 16                 | 9.4            |
| Andean Region                 | 27            | 19                 | 11.2           |
| Cape region                   | 28            | 7                  | 4.1            |
| Northeast Australian region    | 29            | 8                  | 4.7            |
| Southwest Australian region    | 30            | 4                  | 2.4            |
| Central Australian or Eremacan region| 31 | 5 | 2.9 |
| Fernándezian region           | 32            | 1                  | 0.6            |
| Chile-Patagonian region       | 33            | 13                 | 7.6            |
| Subantarctic Islands          | 34            | 1                  | 0.6            |
| New Zealand region             | 35            | 1                  | 0.6            |
| Total                         | 170           | 100.0              |

For thousands of years, Egyptian culture has been associated with many famous popular dishes containing recorded Egyptian crops, such as falafel; which contains: *Vicia faba* (Egyptian bean), *Allium ampeloprasum* (Kurrat), *Allium cepa* (Bulb onion), *Allium sativum* (Garlic), *Petroselinum crispum* (Parley), *Coriandrum sativum* (Coriander) and *Cuminum cyminum* (Cumin). Furthermore, Egyptians are used to eat cooked *Vicia lens* (Lentil) and *Vicia faba* (Egyptian bean) as an inherited food (Abdennour, 2015; Leheta, 2015).

### 4.3. Economic values and Ecological benefits

For economic values; it is estimated that approximately 3,000 plant species have been used as human food throughout history, with approximately 200 having been domesticated as food crops (Simpson and Ogorzaly, 1995). In addition to the most common...
food crops (Oryza sativa, Triticum aestivum, Phaseolus vulgaris, Pisum sativa, Vicia faba, and Zea mays), fresh leaves and young shoots of Malva parviflora (Khubbayza) are cooked as a vegetable dish; fresh leaves and stems of Beta vulgaris (Salq) are eaten cooked as stew or as a soup mixed with lentil; and soft fresh pods of (Al-Eisw and Takruri, 1989). Certain fruit trees, particularly Morus alba, Vitis vinifera, Citrus aurantium, Dianthus sinensis, and Rosa pendulina var. hybrid tea roses, are used as ornamental decorative plants in the Nile Delta (Heneidy, 2010; Soliman and Amer, 2002; Ammar, 2015; Ammar, 2021)).

Citrus aurantifolia (Key lime) is used as a source of volatile oils (limonene and linalool), citric acid, gives tasty for food, medicinal purposes in folk medicine (Heneidy, 2010), while Citrus sinensis (Sweet orange) is used as a source of vitamin C., and Jasminum grandiflorum (Spanish jasmine) gives extracted oil from flowers, used as perfume, and flavor (Heneidy 2010). Citrus aurantium (Bigarade orange), a beta agonist-containing agent, has been reported to help with weight loss (Preuss HG et al., 2002). Citrullus colocynthis, Mentha longifolia, Thymus vulgaris, Moringa oleifera and etc. are used as medicinal plants in a herbal drug industry (Abdel-Azim et al., 2011). Zingiber officinale has been used for centuries in many traditional systems of medicine for its diverse medicinal properties such as antiemetic, stomachic, expectorant, anti-inflammatory, and aphrodisiac. It can be used to treat a variety of gastrointestinal, pulmonary, cardiovascular, and sexual disorders (Imtiyaz et al., 2013). Mentha longifolia and Punica granatum are used as anti-Helicobacter pylori medicinal plants (Hafez et al., 2020). Various bioactive components are capable of extraction from anti-parasitic medicinal plants; Vitis vinifera (Grape seed) eases the coccidiosis by lowering the regulation of oxidative stress, Olea europaea (Olive tree) enhances the anti-coccidial index. Aloe vera (Aloe leave) exhibits considerably intestinal lesions, while Moringa oleifera (Drumstick tree) lessens oocyst number (Jamil et al., 2022).

For ecological benefits; as a result, in cultivated fields, nitrogenous compound-rich fertilisers are frequently required. Because the bacteria convert atmospheric nitrogen into ammonia, plants with nodulating bacteria have overcome the problem of obtaining usable nitrogen (Simpson and Ogorzaly, 1995). Soybean (Glycine max L.), faba bean (Vicia faba L.), chickpea (Cicer arietinum L.),...
and cowpea (*Vigna unguiculata* (L.) Walp.), improve soil quality as green manure when cycled or utilised as intercrops between cereals, depending on the region (Williams et al., 2014) and (Denton et al., 2017) and (Ma et al., 2022). Short high-temperature stress events that reduce photosynthesis and increase oxidative stress in *Glycine max* (soybean) resulted in non-significant losses to soybean production in the Midwest (Siebers et al., 2015).

Ten crop plant species were tested for insect and pest resistance in this study. Brassicaceae food crops, such as mustard and canola oil, share a pungent flavour that is imparted by a class of compounds known as mustard oil glycosides, or glucosinolates. While not toxic to humans in the amounts consumed, mustard oils have been shown to be toxic to insects (Simpson and Ogorzaly, 1995). Sand controllers, such as sand accumulation and windbreaks, have

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**Fig. 6.** Frequency of the recorded crop species in the Nile Region in relation to their world terrestrial biomes and number of biomes. Biomes are; TEE: temperate deciduous forest and subtropical evergreen forest, TEG: temperate grasslands, DES: desert and semi-desert, TRR: tropical rainforest, TRD: tropical deciduous forest and savanna, BOF: boreal forest, ARI: arctic tundra and ice, TER: temperate rainforest and ALT: alpine tundra.

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**Panel a:** Frequency of the recorded crop species in the Nile Region in relation to their world terrestrial biomes.

**Panel b:** Frequency of the recorded crop species in the Nile Region in relation to number of biomes.
been observed to effectively deal with drift sand (Simpson, 1932). *Ricinus communis* and *Phoenix dactylifera* are two sand controllers that make effective wind breaks (Shaltout and Ahmed, 2012; El-Beheiry et al., 2015; Ammar, 2015; E. E. Ammar et al., 2020; Ammar, 2021).

4.4. Global phyto-geographic regions, continental distribution and biomes

For the world endemism and global phyto-geographic regions of the recorded plants; Mediterranean and Saharan-Arabian regions were the most represented (42.9 %), then Sudan-Zambebian region (28.8 %). About the continental distribution, 63.5 % of Egyptian crops were originated from Africa and 39.7 % from Asia. Egypt’s ecosystem is associated with distinct biotic regions of these continents due to its location at the crossroads of three continents (Africa, Asia and Europe). The biotic regions of the country’s north (Nile Delta and Mediterranean coasts) are associated with those of the Mediterranean Basin, while the eastern part is associated with the Levant and the Arabian Peninsula, and the southern (Nile Valley) is associated with the Sudanese and tropical Africa, implying that the majority of its natural flora originated in regions 6 and 7 (Ammar, 2021).

Regarding to biomes, 75.3 % species are originated in temperate deciduous forest and subtropical evergreen forest biomes, 70.0 % species in temperate grasslands, 62.9 % in desert and semi-desert. As Egypt is located in temperate grassland, desert and semi-desert biomes (Lomolino et al., 2017). Thus, it is suitable for the growth of a wide range of plants, especially drought and heat tolerant plants (e.g., *Carica papaya*, *Helianthus annuus* and *Phoenix dactylifera*) (El-Beheiry et al., 2015; Ammar, 2021).

5. Conclusion

According to this assessment, the majority of the Egyptian crop basket were originated in Asia, in addition the huge introduction of them back to the Pharaonic era. All these findings indicate to the relative stability of the Egyptian climate over time. As this result, eradicating poverty and hunger in Egypt is not as difficult as it is in countries where environmental and behavioural conditions are changing, so the ability of support the sustainable development goals of the United Nations is possible obviously e.g., the first goal (no hunger) and the second goal (zero hunger) (https://aer.eu/sustainable-development-goals-engaging-regions/).

6. Future prospective

The future prospective is how to join distribution and cultivated areas of crop species with climate features and population percentage in each area. This will be associated with the 13th goal of sustainable development (climate action) and the life on land (the 14th goal), and this studies exactly will support the food insurance. All these findings will indirectly enhance of crop productivity the educational level, the 4th goal (good education). As the study of diversity in one side, in addition to the nature and diversity of soil in Egypt will help determining the appropriate types of crops for each kind of soil in each region. This already will promote the cultivation of the appropriate crop in the appropriate area to obtain the highest crop productivity naturally, and then provide new job opportunities and raise the standard of living, which indirectly enhances gender equality, especially in education and work (the goal 5th) (https://aer.eu/sustainable-development-goals-engaging-regions/). Current and future scientific research will support more using the contemporary biotechnological techniques to increase the productivity of strategic crops, which increases their resilience to climatic change and emergency environments and enhances their plant and nutritional qualities, all of which will contribute to achieving the desired level of food security (Ammar et al., 2021). In addition to the use of bio-degradable fertilizers extracted from algae and harvested plant residues, it will help increase soil fertility and reduce its desertification, which supports healthy and safe plant growth for crops with high efficiency in the face of any emergency environmental and climatic changes, so this will support the introduction of new crops to the study area and elevation of its crop diversity (Ammar et al., 2022). Additionally, the majority of the world is now turning to the use of biodegradable materials in the cultivation of its strategic crops, such as bio herbicides, bio insecticides, and bio pesticides, which reduce soil stress and prevent the accumulation of toxic substances in the tissues of agricultural crops, particularly food, in order to achieve food security for humans and good health together within the framework of the United Nations’ sustainable development goals (Aioub et al., 2022) (https://aer.eu/sustainable-development-goals-engaging-regions/).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

The current examined 170 crop species, sub-species or varieties around the Egyptian Nile River, Eastern North Africa. Growth forms: HP: herbaceous plants, TS: trees-shrubs, CC: climbers-creepers, CS: cacti-succulents, AQ: aquatic-semi aquatic plants, PP: palms-palm likes and CO: conifers. **Sex forms**: Bi: bisexual, Mono.: monococious, Di: dioecious, Poly: polymamous and Sp: spores. **Propagation methods**: SD: seeds, CT: cutting, RH: rhizomes, OF: offsets, GR: grafting, BB: bulbs, SU: suckers, CO: corms, AI: air-layering, ST: stolons, SP: spores and BD: buds. **Flowering time (months)**: 1: January, 2: February, 3: March, 4: April, 5: May, 6: June, 7: July, 8: August, 9: September, 10: October, 11: November and 12: December. **Ecological benefits**: HT: humidity tolerant, CT: cold tolerant, DT: drought tolerant, SS: shade source, TT: heat tolerant, NF: Nitrogen fixers, ...
AT: animal tolerant, PR: resistant to insects and pests, ST: salinity tolerant, WB: wind breakers, LT: light tolerant, PH: pH maintainers, SA: sand accumulators and AP: Air purifications. **Economic values:** FD: food, MD: medicine, DE: decoration, OT: other uses (e.g., industry, fuel, dyes and oils), GR: grazing and TI: timbers. **Agricultural Habitats:** Wf: winter crop fields, Sf: Summer crop fields, SS: Late summer or late winter crop fields and OR: orchards (fruit or ornamental trees).

| Latin name                  | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|-----------------------------|-------------|----------|---------------------|------------------------|--------------------|-----------------|-----------------------|-----------------------------|
| **Actinidiaceae** Gilg and Werderm. |             |          |                     |                        |                    |                 |                       |                             |
| *Actinidia chinensis* Planch. | TS          | Mono     | SD                  | 5, 6                   | SS                 | FD, ME          | OR                    | 1900s-1950s                 |
| **Amaryllidaceae** J.St.Hil. |             |          |                     |                        |                    |                 |                       |                             |
| *Allium ameloprasum* L.     | HP          | Bi       | SD, BB, Of          | 1, 2                   | HT, CT             | FD, ME, WF      | Pharaonic             |                             |
| *Allium fistulosum* L.      | HP          | Bi       | SD, BB, Of          | 2                      | HT, CT             | ME, OT, WD      | Pharaonic             |                             |
| *Allium sativum* L.         | HP          | Bi       | SD, BB, Of          | 2                      | HT, CT             | ME, OT, WD      | Pharaonic             |                             |
| *Allium schoenoprasum* L.   | HP          | Bi       | SD, BB, Of          | 2                      | HT, CT             | FD, ME, WF      | Ancient Greek         |                             |
| *Allium ursinum* L.         | HP          | Bi       | SD, BB, Of          | 2                      | HT, CT             | DE, ME, WF      | Ancient Greek         |                             |
| **Anacardiaceae** R. Br.    |             |          |                     |                        |                    |                 |                       |                             |
| *Mangifera indica* L.       | TS          | Bi       | SD                  | 5, 6                   | SS                 | FD, TI, OR      | Pharaonic             | 1800s-1850s                 |
| **Annonaceae** Juss.        |             |          |                     |                        |                    |                 |                       |                             |
| *Annona cherimola* Mill.    | TS          | Bi       | SD, GR             | 5, 6                   | SS                 | FD, FD, ME, OT, TI, OR | Pharaonic             |

**Appendix. count. 1.**

| Latin name                  | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|-----------------------------|-------------|----------|---------------------|------------------------|--------------------|-----------------|-----------------------|-----------------------------|
| **Apiaceae** Lindl.         |             |          |                     |                        |                    |                 |                       |                             |
| *Ammi majus* L.             | Hp          | Bi       | SD                  | 4, 5, 6, 7, 8, 9, 10, 11, 12 | AT                 | ME, Sf, SS      |                       |                             |
| **Anthemis graveolens** L.  | HP          | Bi       | SD                  | 8, 9                   | AT                 | FD, ME, Sf      | Pharaonic             |                             |
| **Anthriscus cerefolium** (L) Hoffm. | HP          | Bi       | SD                  | 3, 4, 5               |                    | FD, ME, SS      | Pharaonic             |                             |
| *Apium graveolens* L.       | HP          | Bi       | SD                  | 5, 6, 7, 8            |                    | FD, ME, Sf      | Pharaonic             |                             |
| *Carum carvi* L.            | HP          | Bi       | SD                  | 5, 6, 7, 8            |                    | FD, ME, Sf      | Pharaonic             |                             |
| *Coriandrum sativum* L.     | HP          | Bi       | SD                  | 3, 4, 5, 6            | HT, CT             | FD, OT, ME, WF   | Pharaonic             |                             |
| *Cuminum cyminum* L.        | HP          | Bi       | SD                  | 6, 7                  |                    | FD, ME, Sf      | Pharaonic             |                             |
| *Daucus carota* L.          | HP          | Bi       | SD                  | 6, 7, 8               |                    | FD, OT, SS, Sf, WF, SS | Pharaonic             | 1850s-1900s                 |
| *Foeniculum vulgare* Mill.  | HP          | Bi       | SD                  | 6, 7                  | AT                 | FD, ME, Sf, WF, SS | Pharaonic             |                             |
| *Petroselinum crispum* (Mill.) Fuss. | HP          | Bi       | SD                  | 3, 4, 5               | HT, CT             | FD, ME, Sf, WF, SS | Pharaonic             |                             |
| *Pimpinella aromatic* M. Bieb. | HP          | Bi       | SD                  | 6, 7                  | NF                 | FD, ME, Sf, WF, SS | Pharaonic             |                             |
| **Araceae** Juss.           |             |          |                     |                        |                    |                 |                       |                             |
| *Colocasia esculenta* (L.) Schott. | HP          | Mono     | OF CO               | 1, 2                  | HT, CT             | FD               | Pharaonic             |                             |
| **Arecaceae** Schultz Sch.  |             |          |                     |                        |                    |                 |                       |                             |
| *Phoenix dactylifera* L.    | P           | Di       | SD                  | 3, 4, 5               | SS, HT, DT, TT     | FD, DE, ME, OR  | Pharaonic             |                             |
| **Asteraceae** Bercht. and J.Presl |             |          |                     |                        |                    |                 |                       |                             |
| *Calendula officinalis* L.  | HP          | Bi       | SD                  | 1, 2                  |                    | DE, ME          | OR                    | 1900s-1950s                 |
| *Cichorium intybus* L.      | HP          | Bi       | SD                  | 5, 6, 7, 8, 9, 10      |                    | ME, FD          | SS                    | Pharaonic                  |
| *Cynara cardunculus* L.     | HP          | Bi       | SD                  | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 | DT     | FD               | WF, SS             | 1850s-1900s               |
| *Dahlia pinnata* Cav.       | HP          | Bi       | CO, SD, CT, RH      | 6, 7, 8, 12, 1, 2     |                    | DE, ME, Sf      | Ancient Greek          |                             |

(continued on next page)
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|------------------------|--------------------|----------------|----------------------|-----------------------------|
| *Helianthus annuus* L. | HP | Bi | SD, RH, CT | 6, 7, 8 | TT, DT | DE, FD, OT | Sf, Wf, SF, SS | Pharaonic 1850s-1900s |
| *Lactuca sativa* L. | HP | Bi | SD | 4, 5, 6, 7 | LT, PH | DE, ME, OT | DE, ME | Pharaonic |
| *Matricaria chamomilla* L. | HP | Bi | SD, CT | 6, 7, 8, 9, 10, 11 | DE, FD, OT | DE, ME, OT | Sf, Wf, SF, SS | Pharaonic 1850s-1900s |
| *Tagetes erecta* L. | HP | Bi | SD | 6, 7, 8, 9, 10, 11 | LT, PH | DE, ME | Wf, SF, SS | Pharaonic 1850s-1900s |

**Appendix. count. 2.**

| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|------------------------|--------------------|----------------|----------------------|-----------------------------|
| *Brassica juncea* (L.) Czern. | HP | Bi | SD | 1, 2 | PR | FD | Wf | 1850s-1900s |
| *Brassica napus* L. | HP | Bi | SD | 1, 2 | PR | FD | ME | Wf | 1850s-1900s |
| *Brassica nigra* L. | HP | Bi | SD | 1, 2 | PR | FD | Wf | Pharaonic |
| *Brassica cretica* subsp. *cretica* | HP | Bi | SD | 1, 2 | HT, CT, PR | FD | Wf, SF, SS | Pharaonic 1850s-1900s |
| *Brassicaoleracea* L. | HP | Bi | SD | 1, 2 | HT, CT, PR | FD | ME, DE, SF | Wf, SF, SS | Pharaonic 1850s-1900s |
| *Eruca pinnatifida* (Desf.) Pomel | HP | Bi | SD | 12, 1, 2 | HT, CT, PR | ME, FD | SF, SS | Pharaonic 1900s-1950s |
| *Raphanus raphanistrum* subsp. *sativus* (L.) Domin | HP | Bi | SD | 12, 1, 2 | HT, CT, PR | ME, FD | SF, SS | Pharaonic 1900s-1950s |
| *Sinapis alba* L. | HP | Bi | SD | 12, 1, 2 | PR | FD, ME | Wf | Pharaonic |
| *Cactaceae* Juss. | CS | Bi | CT | 3, 4, 5 | DT, ST, HT, TT | DE | OR | 1900s-1950s |
| *Carica papaya* L. | TS | Poly | SD | 12, 1, 2 | HT, CT | DE | OR | 1800s-1850s |

**Appendix. count. 3.**

| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|------------------------|--------------------|----------------|----------------------|-----------------------------|
| *Beta vulgaris* L. | HP | Bi | SD | 12, 1, 3 | HT, CT | FD, ME | Wf | Pharaonic 1850s-1900s |
| *Spinacia oleracea* L. | HP | Bi | SD | 12, 1, 2, 4, 5, 6 | HT, CT | FD | Wf | 1850s-1900s |
| *Ipomoea batatas* (L.) Lam. | HP | Bi | CO | 3, 4, 5 | TT, HT | FD | Wf, SF, SS | 1800s-1850s |
| *Cucumis sativus* L. | CC | Bi | SD | 3, 4, 5, 6, 7, 8, 9 | TT, HT | FD | SF, SS | Pharaonic |
| *Cucumis melo var. cantalupensis* Naudin. | CC | Mono | SD | 3, 4, 5, 6, 7, 8, 9 | TT, HT | FD | SF, Wf, SS | 1950s-2000s |
| *Cucumis melo var. dudaim* (L.) Naudin. | CC | Mono | SD | 3, 4, 5, 6, 7, 8, 9 | TT, HT | FD | SF | 1800s-1850s |
| *Cucumis melo var. flexuosus* (L.) Naudin. | CC | Mono | SD | 3, 4, 5, 6, 7, 8, 9 | TT, HT | FD | SF, SS | 1800s-1850s |
| *Cucurbita moschata* Duchesne ex Poir. | CC | Mono | SD | 9, 10, 11 | CT | FD, ME | Wf | Pharaonic |
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|-------------------------|---------------------|-----------------|-----------------------|-----------------------------|
| Cucurbita pepo L. **Luffa aegyptiaca** Mill. | CC CC | Mono Bi | SD SD | 7, 8 9, 10, 11, 6, 7, 8 | TT, HT, AT DT, TT | FD, ME OT, DE | SF, WF, SS WF | Pharaonic 1850s-1900s |
| **Cupressaceae** S. F. Gray | CF Sp | Sp | SP | DT, ST | TI, DE, OT OR | - | - | - |
| Callitris rhomboidea R.Br. ex Rich. | CF OWN | OWN OWN | OWN OWN | OWN OWN | OWN OWN | OWN OWN | OWN OWN | OWN OWN |
| **Appendix. count. 4. Latin name** | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
| **Cyperaceae** Juss. | AQ Bi | RH | 3, 4, 5, 9, 10, 11 | CT | OT, ME SS | Pharaonic |
| **Cyperus papyrus** L. | AQ Bi | OF, SD, RH | 3, 4, 5, 9, 10, 11 | TT, DT | DE, OT, ME SS | Pharaonic |
| **Ebenaceae** Gürke | TS Di | SD, GR | 3, 4, 5 | HT, CT | DE, FD, ME OR | 1900s-1950s |
| **Diospyros kaki** Thunb. | TS | Di | SD, GR | 3, 4, 5 | HT, CT | DE, FD, ME OR | 1900s-1950s |
| **Euphorbiaceae** A. Juss. | TS Mono | SD | 3, 4 | WB, SA, SS PR | OT, ME, DE OR | Pharaonic |
| **Ricinus communis** L. | TS | Mono | SD | 3, 4 | WB, SA, SS PR | OT, ME, DE OR | Pharaonic |
| **Fabaceae** Lindl. | HP Bi | SD | 5, 6, 7, 8 | HT, CT, NF | FD, OT, TI, ME SF | Pharaonic |
| **Arachis hypogaea** L. | HP Bi | SD | 5, 6, 7, 8 | HT, CT, NF | FD, OT, TI, ME SF | Pharaonic |
| **Cicer arietinum** L. | HP Bi | SD | 5, 6, 7, 8 | HT, CT, NF | FD, OT, TI, ME SF | Pharaonic |
| **Glycine max** (L.) Merr. | HP Bi | SD | 5, 6, 7, 8 | HT, CT, NF | FD, OT, TI, ME SF | Pharaonic |
| **Glycyrrhiza glabra** L. | HP Bi | BD, CT | HT | ME, FD Wf, SS SF | Pharaonic 1850s-1900s |
| **Lupinus albus** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Medicago falcata** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Phaseolus acutifolius** A. Gray | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Phaseolus lunatus** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Lathyrus oleraceus** Lam. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Phaseolus vulgaris** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Cicer arietinum** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia faba** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia lens** (L.) Coss. & Germ. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia sativa** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vigna unguiculata** (L.) Walp. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Trifolium alexandrinum** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Trifolium repens** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Trigonella foenum-graecum** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Trigonella foenum-graecum** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia faba** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia lens** (L.) Coss. & Germ. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vicia sativa** L. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Vigna unguiculata** (L.) Walp. | HP Bi | SD | 12, 1, 2 | HT | ME FD, ME WF | Pharaonic 1850s-1900s |
| **Geraniaceae** A. Juss. | HP Bi | SD, CT | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 | DE, OT OR | - | 1850s-1900s |
| **Pelargonium graveolens** L’Hérit. | HP Bi | SD, CT | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 | DE, OT OR | - | 1850s-1900s |

(continued on next page)
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|-------------------------|---------------------|-----------------|----------------------|--------------------------|
| Iridaceae Juss. | Gladiolus abbreviatus Andrews | HP | Bi | CO | 3, 4, 5 | HT, CT | DE | OR | 1850s-1900s |
| Juglandaceae DC. ex Perleb | Carya illinoinensis (Wangenh.) K.Koch. | TS | Bi | SD | 6, 7, 8 | AT | ME | Sf | > 2000s |
| Juncaceae Juss. | Juncus acutus L. | HP | Bi | SD, CT | 3, 4, 5 | HT, CT | DE, FD, OT, ME | OR | Pharaonic |
| Lamiaceae Martynov | Melissa officinalis L. | HP | Bi | SD | 6, 7, 8 | TE, DT | ME | FD, DE | OR | Pharaonic |
| | Mentha longifolia (L.) L. | HP | Bi | RH, ST | 6, 7, 8 | TE, DT | ME, DE, ME | FD, OT | Pharaonic |
| | Mentha × piperita L. | HP | Bi | SD, CT | 3, 4, 5 | HT, CT | ME, DE, ME | FD, OT | Pharaonic |
| | Ocimum basilicum L. | HP | Bi | SD, CT | 3, 4, 5 | HT, CT | ME, DE | FD, OT | Pharaonic |
| Appendix. count. 6. | | | | | | | | | |
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|-----------|-------------|----------|---------------------|-------------------------|---------------------|-----------------|----------------------|--------------------------|
| | Origanum majorana L. | HP | Bi | SD | 6, 7, 8 | AT | ME | Sf | Pharaonic |
| | Salvia rosmarinus Spenn. | HP | Bi | SD, CT | 9, 10, 11 | TT, DT | ME | FD, DE, TI | OR | 1900s-1950s |
| | Thymus vulgaris L. | HP | Bi | SD | 5, 6 | AT, DT, AP | ME | DE, ME | Sf | Pharaonic |
| | Lauraceae Juss. | Persea americana Mill. | TS | Bi | SD | 3, 4, 5 | HT, CT, SS | ME, DE | FD | OR | Pharaonic |
| | Linaceae S. F. Gray | Linum usitatissimum L. | HP | Bi | SD | 3, 4 | HT, CT | ME, FD, OT | FD | OR | Pharaonic |
| | Lythraceae J.St.-Hil. | Lawsonia inermis L. | TS | Bi | SD, CT | 6, 7, 8 | SS | ME, DE | FD | OR | Pharaonic |
| | Punica granatum L. | TS | Bi | ND | 6, 7, 8 | SS | ME, DE | FD | OR | Pharaonic |
| Malvaceae Juss. | Abelmoschus esculentus (L.) Moench | TS | Bi | SD | 3, 4, 5, 6, 7, 8 | SS | FD | Sf, SS | Pharaonic |
| | Corchorus olitorius L. | HP | Bi | SD | 3, 4, 5 | 12, 1, 2, 3, 4, 5 | FD, ME | Sf, SS | Pharaonic |
| | Glossostemon bruguieri Desf. | HP | Bi | SD | 6, 7, 8 | DT, CT | ME, FD | Sf, SS | Pharaonic |
| | Gossypium herbaceum L. | HP | Bi | SD | 6, 7, 8 | DT, CT | ME, FD | Sf, SS | Pharaonic |
| | Gossypium barbadense L. | HP | Bi | SD | 8, 9, 10 | DT, CT | ME, FD | Sf, SS | Pharaonic |
| | Hibiscus sabdariffa L. | HS | Bi | SD | 9, 10, 11, 12, 1 | HT | FD, ME | Sf, SS | Pharaonic |
| | Malva parviflora L. | HP | Bi | SD | 9, 10, 11, 12, 1 | HT | FD, ME | Sf, SS | Pharaonic |
| Moraceae Link | Ficus carica L. | TS | Mono | CT | 6, 7, 8, 2, 3, 4, 5 | TE, DT, SS | FD, OT | OR | Pharaonic |
| | Morus alba L. | TS | Di | CT, AL | 2, 3, 4, 5 | SS | FD, DE, OT, ME | OR | Pharaonic |
| Appendix. count. 7. | | | | | | | | | |
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|-----------|-------------|----------|---------------------|-------------------------|---------------------|-----------------|----------------------|--------------------------|
| | Moringaceae R. Br. | Moringa oleifera Lam. | TS | Bi | SD | 1, 2, 3, 4, 5, | DT, SS | FD, ME | WF, Sf, SS | 1800s-1850s |
| | Musaceae Juss. | Musa lutea R.V. Valmayor, L.D.Danh & Häkkine | HP | Mono | OF, SU | 8, 9, 10 | HT, TT, DT | FD, DE, OT | OR | Islamic |
| Latin name | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|------------|-------------|----------|---------------------|------------------------|-------------------|-----------------|---------------------|--------------------------|
| Musa x paradisiaca L. Myristicaceae R.Br. Myristica fragrans Houtt. Myrtaceae Juss. Syzygium cumini (L.) Skeels Psidium guajava L. Oleaceae Hoffmannsegg and Link Jasminum grandiflorum L. Jasminum sambac (L.) Aiton Olea europaea L. Papaveraceae A. Juss. Papaver somniferum L. Pedaliaceae R.Br. Sesamum oleiferum Moench Appendix. count. 8. Latin name | HP | Mono | OF, SU | 8, 9, 10 | HT, TT, DT | FD, DE | OR | 1800s-1850s |
| Poaceae Barnhart Echinochloa crus-galli (L.) Beauv Echinochloa stagnina (Retz.) P. Beauv. Cenchrus setaceus (Forsk.) Morrone Cymbopogon citratus (DC. Ex Nees) Stapf. Hordeum marinum Huds. Hordeum × intermedium (Körn.) Carleton Hordeum vulgare L. Oryza sativa L. Saccharum officinarum L. Sorghum × drummondii (Nees ex Steud.) Millsp. & Chase Sorghum bicolor x S. bicolor var. sudanese Sorghum bicolor (L.) Moench Taeniatherum caput-medusae (L.) Nevski Triticum aestivum L. Triticum durum Desf. Triticum turgidum L. Zea mays L. Zizania aquatica L. Appendix. count. 9. Latin name | HP | Bi | SD | 12, 1, 2 | HT, CT | GR, OT | Wf | 1900s-1950s |
| (continued on next page) |  |  |  |  |  |  |  | |
| Latin name          | Growth form | Sex form | Propagation methods | Flowering time (months) | Ecological benefits | Economic values | Agricultural Habitats | Date of introduction (eras) |
|---------------------|-------------|----------|---------------------|-------------------------|---------------------|------------------|-----------------------|-----------------------------|
| **Portulacaceae** A. Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Portulaca oleracea sub sp. sativa | HP | Bi | SD | 6, 7, 8, 9, 10, 11 | DT | FD, ME | SF, SS | Pharaonic |
| **Ranunculaceae** A. Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Nigella sativa L. | HP | Bi | SD | 5, 6 | ME, FD, OT | SF | 1850s-1900s |
| **Rhamnaceae** Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Ziziphus jujuba Mill. | TS | Bi | SD | 6, 7, 8, 9, 10 | SS | FD, DE | SF | 1850s-1900s |
| Ziziphus spina-christi (L.) Desf. Willd. | TS | Bi | SD, CT | SS, SL, WB, DT, CT | FD, DE, Ti, OT | Pharaonic |
| **Rosaceae** A. Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Rhaphiolepis bibas (Lour.) Galasso & Banfi | TS | Bi | SD, CT | 12, 1, 2 | HT, CT | DE, FD | OR | 1850s-1900s |
| **Fragaria** × ananassa Duchesne | HP | Bi | SU | 3, 4, 6 | HT, CT | FD | OR | 1800s-1850s |
| Fragaria vesca L. | HP | Bi | SU | 3, 4, 5 | HT, CT | FD | OR | 1850s-1900s |
| Prunus armeniaca L. | TS | Bi | SD | 3, 4 | HT, CT, SS | FD, DE | OR | Pharaonic |
| Prunus cerasus L. | TS | Bi | SD | 4 | HT, CT, SS | FD | OR | 1900s-1950s |
| Prunus domestica L. | TS | Bi | SD | 3, 4 | HT, CT, SS | DE | OR | Pharaonic |
| Prunus dulcis (Mill.) D.A. Webb. | TS | Bi | SD | 3, 4 | HT, CT, SS | FD, DE | OR | Pharaonic |
| Prunus persica (L.) Batsch | TS | Bi | SD | 3, 4, 5 | HT, CT, SS | FD | OR | 1900s-1950s |
| **Rutaceae** A. Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Citrus × aurantiifolia (Christm.) Swingle | TS | Bi | SD, GR | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 | SS | DE, ME, FD, OT | OR | Pharaonic |
| Citrus × aurantium L. | TS | Bi | SD | SS | DE, FD, OT | OR | 1900s-1950s |
| Citrus × limon (L.) Osbeck | TS | Bi | SD | SS | DE, FD, OT | OR | 1900s-1950s |
| Citrus reticulata × sinensis | TS | Bi | SD, CT | 3, 4 | HT, CT, SS | DE, FD | OR | 1900s-1950s |
| Citrus reticulata Blanco Osbeck. | TS | Bi | SD, GR | 3, 4 | HT, CT, SS | DE, OT, FD | OR | Pharaonic |
| Citrus sinensis (L.) Osbeck. | TS | Bi | SD, GR | 3, 4 | HT, CT, SS | DE, OT, FD | OR | Pharaonic |
| Citrus x paradisi Macfad. | TS | Bi | SD | 3, 4 | HT, CT, SS | FD | OR | 1900s-1950s |
| **Solanaceae** Juss. |             |          |                     |                         |                     |                  |                       |                             |
| Capsicum annuum L. | HP | Bi | SD | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 | DT | ME, FD | WF, SF, SS | 1850s-1900s |
| Capsicum baccatum L. | HP | Bi | SD | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 | DT | ME, FD | WF, SF, SS | 1850s-1900s |
| Datura stramonium L. | HP | Bi | SD | 5, 6, 7 | TT, DT | ME | SF | Pharaonic |
| Solanum lycopersicum L. | HP | Bi | SD | 9, 10, 11 | TT, DT | FD | WF, SF, SS | 1850s-1900s |
| Solanum melongena L. | HP | Bi | SD | TT | FD, GR | WF, SF, SS | Pharaonic |
| Solanum tuberosum L. | HP | Bi | CT | AT | FD | WF, SF, SS | 1800s-1850s |
| **Strelitziaeae** Hutch. |             |          |                     |                         |                     |                  |                       |                             |
| Strelitzia reginae Aiton | TS | Bi | OF, SD, CT, RH | 12, 1, 2, 3, 4, 5 | HT, CT, SS | DE, OT | OR | 1850s-1900s |
| **Theaceae** D. Don. |             |          |                     |                         |                     |                  |                       |                             |
| Camellia sinensis (L.) Kuntze | HP | Bi | SD | 10, 11, 12 | HT | ME, FD | OR | 1800s-1850s |
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