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Prioritization of Potential Native Plants from Arabian Peninsula Based on Economic and Ecological Values: Implication for Restoration

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Abstract: Land degradation is one of the most important environmental problems worldwide, including in the Arabian Peninsula. In arid climatic conditions (i.e., high temperature, high evaporation, scanty rainfall and high salinity), anthropogenic factors (i.e., grazing, camping, infrastructure development, etc.) are the major causes of land degradation. Therefore, restoration of degraded lands is urgently needed to achieve sustainable development goals. Moreover, countries in the Arabian Peninsula are suffering from a lack of natural freshwater resources. Therefore, using halophytes could be an environmentally and economically viable option to overcome limited availability of fresh water by substituting the demand of portable water for irrigation as well as restoring salt-affected lands. Saline soils are common in the Arabian Peninsula, therefore, exploring the ecological and economic potential of halophytes and incorporating them in restoration projects could be a sustainable option. In this study, an attempt was made to document the uses of Arabian halophytes through a survey of the literature and prioritizing them based on their use value. Out of the 107 species studied, 4 species, namely *Arthrocnemum macrostachyum* (Moric.) K.Koch., *Alhagi graecorum* Boiss., *Bassia muricata* (L.) Asch. and *Phragmites australis* (Cav.) Trin. Ex Steud., were categorized as high priority followed by 36 species under moderate priority. However, when the priority and life form of species was considered for prioritization, three species, namely *Alhagi graecorum*, *Arundo donax* L. and *Phragmites australis*, ranked at the top in the priority list among perennials and *Bassia muricata* ranked at the top among annuals. This information could be useful for land restoration specialists to use appropriate halophyte species to achieve for different restoration objectives in salt-affected lands. However, there is a need to develop an active monitoring system that strictly concentrates on the recycling of plants that are used in phytoremediation.

Keywords: degradation; halophyte; restoration; salinity; water resources

Citation: Bhatt, A.; Bhat, N.R.; Suleiman, M.K.; Al-Mansour, H. Prioritization of Potential Native Plants from Arabian Peninsula Based on Economic and Ecological Values: Implication for Restoration. *Sustainability* **2023**, *15*, 6139. https://doi.org/10.3390/su15076139

Academic Editor: Pablo Peri

Received: 28 August 2022
Revised: 14 November 2022
Accepted: 22 November 2022
Published: 3 April 2023

1. Introduction

Land degradation is considered the number one cause of depleting biodiversity and ecosystem services throughout the world, including in the Arabian Peninsula, which includes Bahrain, Kuwait, Oman, Qatar, the United Arab Emirates (UAE), Saudi Arabia, Yemen, part of Iraq and the southern part of Jordan. It is characterized by extremely hot and dry climate (temperature reaching up to 50 °C at some places during summer), scanty and infrequent rainfall (<250 mm) and limited renewable groundwater resources [1,2]. The soils of this region are subjected to wind and water erosion and degradation through salinization. Although the total area of Arabian Peninsula is about 259 million hectares, over 90% of the land area suffers from some sort of degradation [3]. Moreover, most of the areas in this region present highly challenging conditions for plant survival and growth due to extreme climatic condition and high soil salinity. Besides these, soil and water contamination by petroleum hydrocarbons as well as organic and inorganic pollutants are other stresses causing severe negative impact on vegetation in the Arabian Peninsula [4]. However, the assessment of soils affected by these pollutants and their effect on vegetation remain poorly understood. Moreover, the natural recovery of vegetation from anthropogenic disturbances in this region is very slow as compared to other regions [5]. Therefore, all these factors need to be considered in order to develop an efficient and effective restoration strategy. Additionally, the Arabian Peninsula is considered to be one of the most vulnerable regions to climate change [6], which may further enhance the negative impact on the resilience of the economy, food security and biodiversity conservation. Therefore, implementation of an effective and sustainable approach for restoration of degraded lands is urgently required to protect biodiversity and soil, provide ecosystem services and mitigate the impact of climate change [7]. Recently, the United Nations Decade of Ecosystem Restoration (2021–2030) set a target of 350 million km^2 globally for restoration of degraded ecosystems to achieve the United Nations' sustainable development goals. Therefore, land restoration becomes a prime concern for ensuring the continuity of natural resources, which are key to sustain life on this planet.

Soil salinity is a one of the major causes of land degradation, especially in the Arabian Peninsula, due to arid climatic conditions. Under such climatic conditions, evaporation (about 1.84 m/year) far exceeds precipitation (about 0.28 m/year), leading to several-fold increase in soil salinity [8] and loss of arable lands [9]. This limits the land available for most non-halophytic species. Therefore, there is an urgent need to develop efficient strategies to utilize salt-affected areas for the ecological and economic wellbeing of the present as well as future generations. Salinity has a negative impact on soil infiltration capacity, vulnerability to erosion, soil respiration, nitrogen cycle and the decomposing functionality of soil microorganisms [10–13]. Consequently, this poses a severe threat to plant productivity, environmental health and the socioeconomic wellbeing of people [14]. Moreover, water is one of the most important and key natural resources that play a key role in sustainable development [15]. However, with only 1.1% of the world's total renewable water resources [16], the Arabian Peninsula region has the lowest absolute and per capita water availability [17]. In contrast, the per capita use of water in this region is the highest in the world. Moreover, continuous population growth further places tremendous pressure on already limited water resources (Table 1). All these factors make this region one of the most antagonistic and fragile environments for plant growth [5,18]. Therefore, sustainable management of land and water resources should be given the top priority in national developmental plans.

Table 1. Past and projected water demand, population growth (2000 and 2025) and annual precipitation in the Arabian Peninsula (Source: [15,19–21]).

Country	Total Water Demand (Million Cubic Meters)		Population Growth (Millions)		Annual per Capita Renewable Water Resources (m^3/Year/Person)	Mean Annual Precipitation (mm)
	2000	2025	2000	2025		
Bahrain	319	574	0.653	1.014	7.65	30–140
Kuwait	590	970	1.718	2.79	6.154	30–140
Qatar	290	485	0.542	0.73	29.30	20–150
Oman	1525	2480	2.168	4.71	462.84	80–400
UAE	2180	3200	1.970	2.79	16	80–160
Saudi Arabia	17,765	24,200	20.677	40.43	86.45	30–550
Yemen	3520	4777	17.80	43.10	73.7	——
Total	26,189	36,686	45.52	95.56	682.09	

Species selection is one of the first and most important steps that play an important role in successful restoration of degraded lands [22]. Species with economic and ecological value and adaptability to the restoration site should be taken into consideration when selecting the species because these factors play an important role in determining long-term restoration success [23–25]. Native plant species are mostly recommended for restoration projects because they are well adopted to the local environmental conditions and thus have greater chances for survival, ensuring the greater success of restoration efforts in terms of biomass production and ecosystem stability. Additionally, the soils of the Arabian Peninsula are enriched with salt [3]. Hence, it would be interesting to explore the ecological and economic potential of those species that are inhibited under such conditions of this region and incorporating them in restoration projects. However, most of these species still remain underused due to ignorance or by not even being known by the inhabitants of the region [23].

The coastal belts of the Arabian Peninsula, which are >9000 km long, are severely threatened due to rising sea levels and dropping water tables [18,26]. However, this region has a rich diversity of halophyte species that are well adapted to grow and proliferate in saline habitats in the coastal and inland areas, salt marshes, sand dunes and deserts (Table 2). Halophytes have the ability to persist and complete their life cycles in a saline habitat. Usually, they are categorized into two groups based on salt demand and tolerance: (i) obligate and (ii) facultative halophytes. Obligate halophytes require salt for their growth and survival (i.e., mangroves, seagrasses and some *Amaranthaceae* species), whereas facultative halophytes grow in both saline and non-saline habitats [27,28]. Moreover, the seeds of facultative halophytes can survive in saline soil for a long time and they can also flower and fruit in such soil, but their seed germination depends on rain that can reduce the surface soil salinity [29]. Additionally, facultative halophytes may also exhibit a range of tolerance to salinity gradients.

Table 2. Country-wise number of halophytic taxa in Arabian Peninsula.

Country	Total Number of Plant Species	No of Halophyte Species	Reference
Bahrain	357	97	[30,31]
Kuwait	378	80	[32,33]
Oman	1047	98	[34]
Qatar	400	49	[35,36]
UAE	731	76	[37–39]
Saudi Arabia	2250	100	[40,41]
Yemen	2838	95	[42]

Halophytes have evolved many unique strategies, including adjustment of their internal water relations through ion compartmentation in cell vacuoles, accumulation of compatible organic solutes, succulence, and salt-secreting glands and bladders that assist them in mitigating salinity stress [43]. Approximately 120 halophytic species from 30 families have been recorded from the Arabian Peninsula, and constitute nearly 4% of the total flora [44]. These species are major components of the vegetation in the Arabian Peninsula and play an important role in maintaining ecological stability and protecting habitats and also have huge potential to add economic development and habitat restoration in salt-affected areas [45]. Halophytes are used for medicine, fodder, phytoremediation, biofuel and greening [45–51]. Therefore, growing halophytes in salt-affected lands could be an economically viable option for utilizing saline soils and for conserving fresh water resources. Here, we documented the uses of Arabian halophytes through a survey of the literature and then prioritized them based on their economic and ecological potential to encourage different stakeholders to utilize them to meet their requirement (monitory or non-monitory) for restoring salt-affected lands and promoting ecosystem stability.

2. Material and Methods

The halophytic plants of the Arabian Peninsula are listed by Ghazanfar et al. [44]. The published literature (i.e., journals, textbooks, proceedings, websites, periodicals and databases) on the potential ecological and economical value of these species were critically evaluated (Table S1). A total of 122 published articles were examined to compile information on the use value. Out of 120 species, 13 species were excluded for lack of information on their use value (Table S1). Information on the salinity tolerance of halophyte species was obtained from the eHALOPH database (https://www.sussex.ac.uk/affiliates/halophytes, accessed on 20 August 2022) (Table S1).

Prioritization of halophytic species was done based on the combined score for each species. The use value of each species was computed using a number of uses (i.e., medicinal, edible, fodder, ornamental, detergent, aromatic, fuel, tanning, soil stabilization, soil fertility enhancement, phytoremediation, windbreak, shading, water storage, aesthetic, and others). The species with higher value scores were given high priority. Species with a total score between 7 and 9 were considered as top priority species, whereas those with a total score between 4 and 6 were considered as moderate and those with a total score < 4 were considered as low priority species.

Life form and priority were used to construct cladograms. First, the life form was transformed into binary numbers, assigning values 0 and 1 to perennials and annual species, respectively. Similarly, a priority value of 1 or 0 was assigned for species with or without specific use, respectively. The priority value was estimated using the following equation:

$$\sum_{i=k}^{i=0} n \tag{1}$$

where i is the first analyzed feature and k the last, and n denotes the binary presence or absence of each feature. The sum of n gives the score for each species. The score was used to assign the priority, where the species that have <4 uses were categorized as low priority and the number 1 was added to this species. Species showing 4 to 6 and >7 uses were grouped as medium and high priority, respectively, and given 2 and 3 numbers, respectively.

To prepare the cladogram, the binary life form was added to the priority score of 1, 2 or 3 as described above. Therefore, all plant species received a two-digit number, where the first represented the life form (0 or 1) and the second the priority (1, 2 or 3).

A cladogram was produced by considering species as independent variables and its code as dependent variables. Using the Minitab software (version 18.1, Minitab, Inc., Boston, MA, USA) all species were processed using this code to generate a phylogenetic tree. The 107 species generated a score combining the sum of the grouped squares (54.7477), mean distance from the centroid (0.6721) and maximum distance from the centroid (1.7435).

3. Results

Among 107 economically and ecologically important halophytic species, 79 species (73.83%) are perennials, whereas the remaining 28 species (26.17%) are annuals (Table S1). These species belong to 28 families and *Amaranthaceae* with 26 species is the most dominant family, followed by *Poaceae* (17 species), Zygophyllaceae (9 species) and *Plumbaginaceae* (6 species). In contrast, three families, *Aizoaceae*, *Ceratophyllaceae*, and *Fabaceae*, have five halophytic species each. The remaining 21 families contain fewer than five halophytic species each (Figure 1).

Out of the 107 species, 62 (57.94%) possess medicinal properties, whereas 53 (49.53%) are suitable as fodder, 24 species (22.43%) are edible and 19 (17.76%) are suitable for aesthetic/ornamental purposes (Figure 2A). In terms of ecological uses, the maximum number of species (106 species or 99.07%) were found suitable for soil stabilization (106 species, 99.07%) followed by phytoremediation (13 species, 12.15%) and windbreak (12 species, 11.21%) (Figure 2B). These species show high variability for salinity tolerance (Table 3).

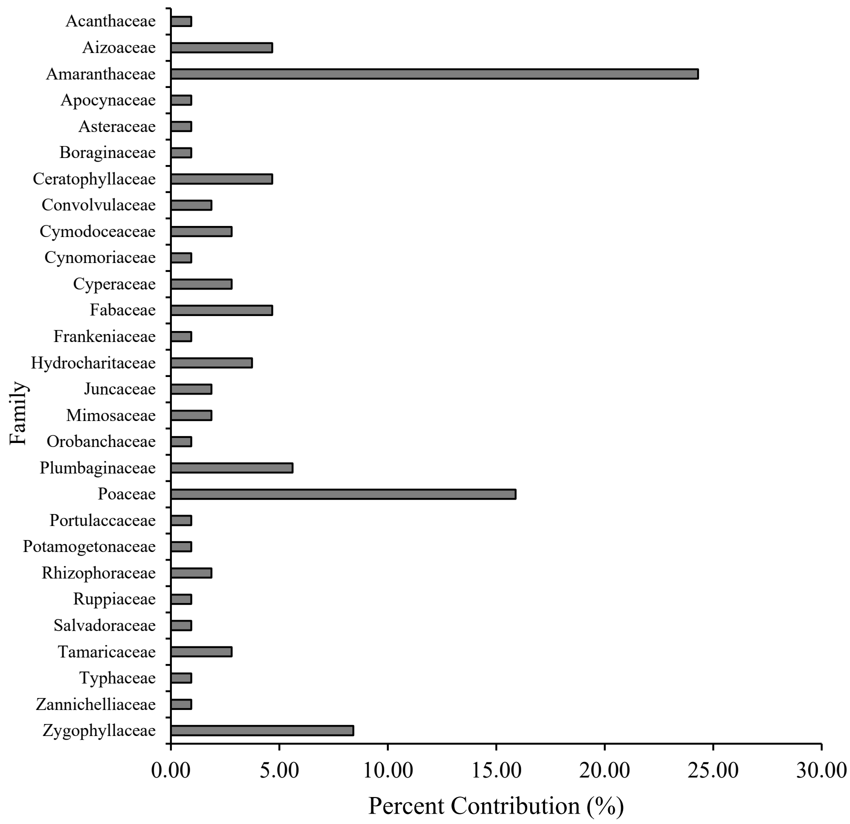

Figure 1. Species contribution (%) in different plant families.

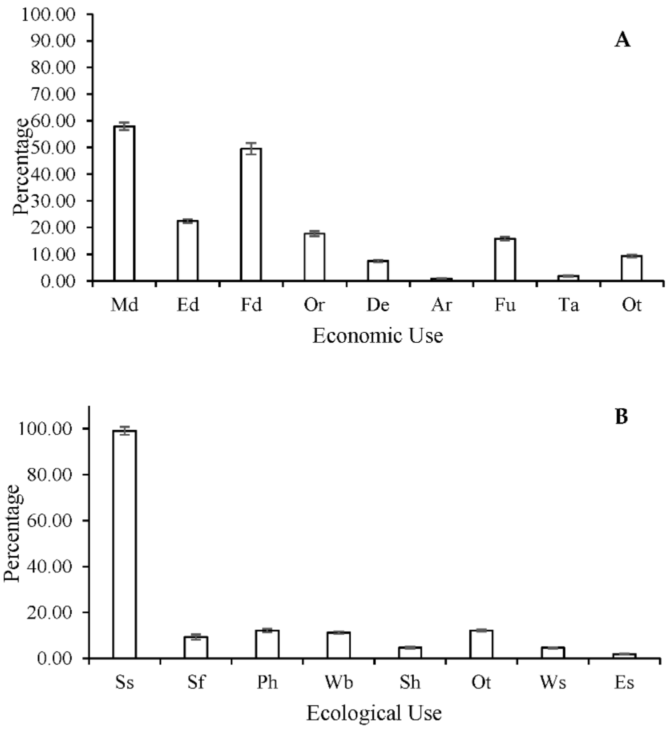

Figure 2. Ecological and economic services provided by the halophytic species. (**A**): Economic uses: Md—medicinal; Ed—edible; Fd—Fodder; Or—ornamental; De—detergent; Ar—aromatic source; Fu—fuel; Ta—tanning; Ot—others (i.e., rope making, thatching and shelter materials, fencing, herbicide and handicraft making). (**B**): Ecological uses: Ss—soil stabilization; Sf—soil fertility improvement; Ph—phytoremediation; Wb—windbreak; Sh—shading; Ws—water storage; Es—aesthetic value; Ot—others (such as provision of pollen to bee and refuge).

Table 3. Species prioritized and categorized based on use value.

Species	Life Form	Score	Priority	Salinity Tolerance (Source: eHALOPH Database)
Arthrocnemum macrostachyum	Perennial	8	High	1030 mM
Alhagi graecorum	Perennial	8	High	
Bassia muricata	Annual	7	High	
Phragmites australis	Perennial	9	High	74.5 dS/m
Mesembryanthemum nodiflorum	Annual	6	Medium	465 mM
Sesuvium portulacastrum	Annual	4	Medium	1000 mM
Zaleya pentandra	Annual	4	Medium	
Pentatropis nivalis	Perennial	4	Medium	
Pluchea dioscorides	Perennial	5	Medium	
Heliotropium bacciferum	Perennial	4	Medium	12 dS/m
Anabasis setifera	Perennial	5	Medium	17.5 dS/m
Atriplex farinosa	Perennial	5	Medium	
Bienertia cycloptera	Annual	4	Medium	400 mM
Caroxylon imbricatum	Perennial	4	Medium	16 dS/m
Halocnemum strobilaceum	Perennial	5	Medium	200 mM
Haloxylon persicum	Perennial	4	Medium	
Suaeda aegyptiaca	Annual	5	Medium	600 mM
Ipomoea pes-caprae	Annual	4	Medium	255 mM
Taverniera lappacea	Perennial	4	Medium	
Taverniera spartea	Perennial	4	Medium	
Juncus rigidus	Perennial	4	Medium	70 dS/m
Juncus acutus	Perennial	4	Medium	600 mM
Acacia tortilis	Perennial	4	Medium	
Prosopis cineraria	Perennial	6	Medium	171 mM
Cistanche phelypaea	Perennial	6	Medium	
Limonium axillare	Perennial	4	Medium	200 dS/m
Aeluropus lagopoides	Perennial	5	Medium	750 mM
Aristida abnormis	Annual	4	Medium	
Arundo donax	Perennial	4	Medium	16 dS/m
Panicum antidotale	Perennial	4	Medium	300 mM
Panicum turgidum	Perennial	6	Medium	
Paspalum vaginatum	Perennial	4	Medium	540 mM
Portulaca oleracea	Annual	4	Medium	200 mM
Potamogeton pectinatus	Perennial	4	Medium	SW
Rhizophora mucronata	Perennial	4	Medium	SW
Salvadora persica	Perennial	5	Medium	750 mM
Tamarix aphylla	Perennial	5	Medium	150 mM
Tamarix aucheriana	Perennial	5	Medium	
Typha domingensis	Perennial	6	Medium	300 mM
Nitraria retusa	Perennial	4	Medium	SW
Sesuvium sesuvioides	Annual	3	Low	
Trianthema triquetra	Annual	2	Low	SW
Avicennia marina	Perennial	3	Low	360 mM
Atriplex stocksii	Perennial	3	Low	350 mM
Atriplex griffithii	Perennial	2	Low	83 dS/m
Atriplex leucoclada	Perennial	3	Low	
Bassia eriophora	Annual	3	Low	
Caroxylon cyclophyllum	Perennial	2	Low	
Caroxylon spinescens	Perennial	2	Low	
Caroxylon villosum	Perennial	2	Low	
Cornulaca aucheri	Annual	2	Low	12 dS/m
Cornulaca monacantha	Perennial	3	Low	
Halopeplis perfoliata	Perennial	3	Low	510 mM
Halothamnus bottae	Perennial	3	Low	
Seidlitzia rosmarinus	Perennial	3	Low	177 dS/m
Suaeda monoica	Annual	3	Low	84.6 dS/m
Ceratophyllum demersum	Perennial	2	Low	

Table 3. *Cont.*

Species	Life Form	Score	Priority	Salinity Tolerance (Source: eHALOPH Database)
Sphaerocoma aucheri	Perennial	2	Low	
Polycarpon succulentum	Annual	2	Low	
Spergularia diandra	Annual	3	Low	
Spergularia marina	Annual	3	Low	16 dS/m
Cressa cretica	Perennial	3	Low	850 mM
Hammada salicornica	Perennial	3	Low	
Salicornia perennans	Annual	2	Low	
Salsola drummondii	Perennial	3	Low	1200 mM
Salsola schweinfurthii	Perennial	3	Low	
Halodule uninervis	Perennial	3	Low	33 dS/m
Syringodium isoetifolium	Perennial	3	Low	SW
Thalassodendron ciliatum	Perennial	2	Low	SW
Cynomorium coccineum	Perennial	2	Low	500 mM
Cyperus arenarius	Perennial	2	Low	
Cyperus conglomeratus	Perennial	3	Low	12 dS/m
Cyperus laevigatus	Perennial	3	Low	30 dS/m
Lotus garcinii	Perennial	3	Low	
Crotalaria saltiaina	Annual	2	Low	
Frankenia pulverulenta	Annual	2	Low	
Halophila ovalis	Perennial	3	Low	SW
Halophila stipulacea	Annual	2	Low	SW
Najas flexilis	Annual	3	Low	
Najas graminea	Annual	3	Low	425 mM
Limonium carnosum	Perennial	2	Low	
Limonium cylindrifolium	Perennial	2	Low	
Limonium milleri	Perennial	2	Low	
Limonium sarcophyllum	Perennial	2	Low	
Limonium stocksii	Perennial	3	Low	60 dS/m
Echinochloa crusgalli	Annual	3	Low	
Halopyrum mucronatum	Perennial	3	Low	180 mM
Paspalidum desertorum	Perennial	2	Low	
Paspalum distichum	Perennial	2	Low	400 mM
Sporobolus consimilis	Perennial	2	Low	
Sporobolus helvolus	Perennial	2	Low	20 dS/m
Sporobolus ioclades	Perennial	2	Low	
Sporobolus spicatus	Perennial	3	Low	84.6 dS/m
Sporobolus virginicus	Perennial	2	Low	1750 mM
Urochondra setulosa	Perennial	2	Low	500 mM
Bruguiera gymnorrhiza	Perennial	3	Low	SW
Ruppia maritima	Annual	2	Low	SW
Tamarix mascatensis	Perennial	3	Low	
Zannichellia palustris	Perennial	2	Low	8.8 dS/m
Fagonia indica	Perennial	2	Low	
Fagonia luntii	Perennial	2	Low	
Fagonia ovalifolia	Annual	2	Low	
Fagonia schweinfurthii	Perennial	2	Low	
Tetraena alba	Perennial	2	Low	82.8 dS/m
Tetraeana qatarensis	Perennial	3	Low	81.9 dS/m
Tetraena simplex	Annual	2	Low	16,300 mg/L
Tribulus arabicus	Annual	3	Low	

The summed score for the species varied from 2 to 9 (Table 3). Out of 107 species, 4 species, namely *A. macrostachyum*, *A. graecorum*, *B. muricata* and *P. australis*, scored seven or more and thus were classified as the top priority species for their uses. However, 36 species had a summed score between 4 and 6 and thus were categorized under moderate priority species. The remaining species possessed relatively low scores (<4) for use value (Table 3).

At 63% of linkage distance, three large groups were formed and these groups were further separated into six subgroups with 44.4% of linkage distance. Among perennials, 46, 30 and 3 species were categorized with low, medium and high priority, respectively. In contrast, among annuals, 19, 8 and 1 species were categorized as low, medium and high priority, respectively (Supplementary Figure S1).

4. Discussion

Land degradation severely impacts biodiversity and ecosystem services and ultimately affects human well-being [52]. Therefore, biodiversity is an essential component for developing guidelines or strategies for natural resources management [53,54]. The selection of species for the restoration of degraded areas without considering their adaptability to the local environmental conditions may have severe negative consequences, such as high mortality, poor ecological and economic returns, and adverse environmental consequences. Therefore, preference should be given to the native plant species because they are well adapted to local environmental conditions (Figure 3). Usually, land restoration activities occur in the context of socio-ecological systems. Therefore, both ecological and economic aspects are important and thus need to be taken into consideration to achieve better outcomes of restoration efforts. Understanding the economic and ecological use value of species will help policy makers to select suitable species based on the priority for land restoration. Therefore, we collected the existing information on use value and compiled it to prioritize Arabian halophyte species efficiently based on evidences.

The Arabian Peninsula represents one of the severe cases of salinization, but at the same time, it contains high halophyte diversity. Our results show that 89.16% of the Arabian Peninsula's halophyte flora have enormous potential as a valuable resource, environmentally, ecologically and economically. Since support from local inhabitants is necessary to achieve better outcomes from restoration, highlighting the ecological and economical significance of plant species to a specific area could be important and can provide new insights and opportunities for sustainable and multipurpose use of resources, which is essential for preserving ecological diversity. Out of 107 species, 62 species were reported to have medicinal uses, followed by fodder (53 species), and edible (24 species) and aesthetic/ornamental values (19 species), indicating their economic and environmental potential (Table S1). Thus, utilizing these species could be better appreciated by the local people because they can provide alternate sources of income to them. However, adequate cautions need to be exercised, especially when utilizing halophyte species for the human diet or as fodder because they may contain high concentrations of toxic or non-nutrient elements that are detrimental to human and animal health through direct ingestion and the food chain [55,56]. Therefore, substantial efforts are needed to monitor when these plants are used for phytoremediation as well as for food and fodder purposes at the same time. Several efforts have been made to use halophytes as a cash crop to enhance the economy; however, extensive efforts are needed to deal with the recycling of these species whenever necessary in order to avoid entering any toxic elements to the food chain.

Similarly, in terms of ecological uses, the majority of these species are suitable for soil stabilization, followed by phytoremediation and others. Plant roots reduce soil erosion by holding the soil together against erosion and soil detachment. However, the rate of erosion may differ due to variations in wind speed, rainfall, soil characteristics, topography and vegetation cover conditions. Therefore, detailed knowledge of the restoration site in terms of exposure to wind/water erosion is required in order to select suitable species according to site conditions. By decreasing soil erosion and accumulating organic matter, the restoration of degraded soil can not only enhance carbon sequestration but also improve the soil quality [57]. Utilizing plants for remediating the polluted soil is considered to be an ecologically sustainable and economically efficient technique. Thirteen halophyte species, namely *Anabasis setifera*, *Atriplex farinose*, *A. griffithii*, *A. leucoclada*, *A. stocksii*, *Bienertia* *cycloptera*, *Caroxylon imbricatum*, *Halopeplis perfoliata*, *Halopyrum mucronatum*, *Potamogeton pectinatus*, *Sesuvium portulacastrum*, *Suaeda monoica* and *Trianthema triquetra* were reported to be effective in phytoremediation of soils polluted with inorganic chemicals, heavy metals and petroleum hydrocarbons. Previous studies have shown that various halophyte species such *as Halopeplis perfoliata*, *Phragmites australis*, *Haloxylon sp.* and *Sporobolus sp*. are effective in remediating inorganic pollutants as well as petroleum hydrocarbons from soil [58,59]. Meanwhile, *Anabasis setifera*, *Atriplex sp.* and *Suaeda sp*. are effective in cleaning soil contaminated with inorganic pollutants and *Halopeplis perfoliata* and *Halopyrum mucronatum* are effective in remediating heavy metals and petroleum hydrocarbons [59]. Information on the ability of these species in remediating different pollutants would be helpful for restoration ecologists to select suitable species based on the nature of the contaminated site. However, further studies on additional halophyte species are needed to understand and identify additional species that could be used for restoring soil contaminated with different pollutants. Different species demonstrated variability in terms of salinity tolerance (Table 3) as well as ability to remediate soil polluted with different pollutants, which could be the adaptive strategy of these species to deal with different salinity/pollution gradients. Therefore, this variability would be helpful in recommending species for different salinity gradients as well as remediating soil with different pollutants based on their tolerance.

Figure 3. Some important halophyte species growing in Arabian Peninsula: (**A**)—Alhagi graecorum; (**B**)—Phragmites australis; (**C**)—Arthrocnemum macrostachyum; (**D**)—Aeluropus lagopoides; (**E**)—Heliotropium bacciferum; (**F**)—Avicennia marina; (**G**)—Nitraria retusa; (**H**)—Tetraeana qatarensis.

Our results could serve as an indicator of dependency and priority of the local inhabitants on halophyte resources in the region and thus could be taken into consideration while selecting the species for restoration. These findings demonstrate the importance of these species not only in soil stabilization and improving soil conditions but also for greening and sustainable development under challenging conditions. Therefore, these species deserve special attention due to their use values [23,45,60–64]. Moreover, utilizing these species for restoring salt-affected lands will not only help in combating land degradation but also in reducing the pressure on already depleting fresh water resources. With increasing population growth and ever-increasing demand for food, fodder, medicine and fuel, the pressure on arable lands has increased by several folds. Therefore, the utilization of halophyte species for restoring degraded salt-affected lands could be a viable option for obtaining direct benefits and also for maintaining ecosystem stability.

Prioritizing species based on use values could be important because it influences local livelihoods, incomes and food and fodder availability; therefore, local stakeholder engagement is critically important in making decisions on species selection for restoration. Moreover, these species provide essential goods and services for human well-being by contributing to human health, livelihood and food security [65]. Therefore, adopting a sustainable approach for conservation of land and water resources is the key for achieving sustainable development goals. Four species, namely *A. macrostachyum*, *A. graecorum*, *B. muricata* and *P. australis* can be utilized for various economic and ecological purposes; therefore, they are ranked high in the priority list. However, other species are ranked as moderate and low priority based on their use value. Promoting the species for restoration of salt-affected lands based on their priority and suitability to different salinity gradients will enhance the interest of local inhabitants.

Species composition (i.e., mixture of both annual and perennial species) is usually recommended for restoration to enhance the diversity. This can ultimately fulfill the goal of enhancing species diversity through restoration [66]. Furthermore, incorporating both annual and perennial species will enhance the array of ecosystem services. Among the perennials, *A. graecorum, A. donax* and *P. australis* ranked at the top in the priority. In contrast, *B. muricata* topped the list among annuals based on life form and use value. These results would serve as guidelines for restoration ecologists in species selection based on the priority. Moreover, selection of species based on priority could be helpful for restoration practitioners to make appropriate decisions and in optimizing future restoration efforts.

Usually, species selections are made based on published information or a specialist's own experience and they mostly ignore local knowledge and the needs of local communities, which ultimately could lead to failure due to lack of interest from the local inhabitants [67]. Besides the economic value, these species provide various ecological services, such as soil stabilization, erosion control, improving soil fertility by fixing nitrogen (i.e., legumes), providing shading, enhancing aesthetic beauty, etc. Therefore, these parameters also need to be taken in to consideration while selecting the species. Most of the prioritized species are perennials; therefore, they can provide a sustainable supply of goods and services from multiple harvests. Moreover, perennial species usually have more developed root systems that facilitate in recovering soil quality, increasing carbon sequestration and avoiding nutrient loss by leaching [68,69]. Further studies are recommended to monitor and classify these species based on the accumulation of toxic elements in their tissue that could be harmful to humans or livestock.

5. Conclusions

The present study provides comprehensive information about Arabian Peninsula halophytes that could be helpful to better understanding and appreciating their multiple use values. Documenting the economic and ecological potential of Arabian Peninsula halophytes will also assist in their conservation and ensuring that the highest priority genetic diversity is preserved and made available for future use. Moreover, this information will provide the opportunity to land restoration specialists to identify the interests of different stakeholders and select appropriate halophyte species for different restoration projects depending on their requirements. Considering these species for restoration will not only have direct impact on economic and ecological significance but also assist in conserving already deteriorating water resources. However, caution needs to be taken, especially when halophytes are utilized as human diet or fodder, because they may contain toxic elements that are detrimental to human and animal health.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15076139/s1, Figure S1: Cladogram based on life form and priority; Table S1: Halophytes of the Arabian Peninsula and their economic and ecological uses (modified after Ghazanfar et al., 2014). Economic uses: Md—medicinal; Ed—edible; Fd—Fodder; Or—ornamental; De—detergent; Ar—aromatic source; Fu—fuel; Ta—tanning; Ot—others (i.e., rope making, thatching and shelter materials, fencing, herbicide and handicraft making). Ecological uses: Ss—soil stabilization; Sf—soil fertility; Ph—phyto-remediation; Wb—windbreak; Sh—shading; Ws—water storage; Es—aesthetic value; Ot—others (such as provision of pollen to bee and refuge).

Author Contributions: Data collection and analysis, A.B.; writing—original draft, A.B.; writing—review and editing, A.B., N.R.B., M.K.S. and H.A.-M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Kuwait Institute for Scientific Research.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated during and/or analyzed during this study are available from the corresponding author on request.

Acknowledgments: We would like to thank Marcelo Francisco Pompelli, University of Cordoba, Cordoba, Colombia for helping with the cladogram. A.B. also thanks Rini Rachel Thomas, Kuwait Institute for Scientific Research for her help.

Conflicts of Interest: The authors declare no conflict of interest.

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