

## Potential use of halophytes with emphasis on fodder production in coastal areas of Pakistan

M. Ajmal Khan and Raziuddin Ansari

*Institute of Sustainable Halophyte Utilization, University of Karachi, Karachi-75270, Pakistan*

### Abstract

Fresh water resources both for domestic and agricultural use are constantly depleting worldwide and crop yields suffer from a steady increase in soil salinity, especially in the arid and semi-arid areas. A burgeoning world population is a further threat to sustained food supply. Equally or even more affected in some cases, are other resources like fodder for animals and fuel wood for the rural poor. Efforts are hence needed to find an alternate source of water and utilization of saline lands for economic benefit. The varied climatic conditions of Pakistan offer opportunities for selecting suitable halophytes for specific purposes. Whereas halophytes may be used for a variety of purposes like food, fiber, fuel wood, medicines, source of chemicals, landscaping, ornamental, carbon sequestration, etc., one of the very important utilities lies in their use as fodder. An animal feeding trial showed that traditional green fodder (maize) and a halophytic grass (*Panicum*) were equally good for growth and development of 1-year-old cow calves. Meat from animals fed 100% *Panicum* was leaner and hence better for human consumption from health point of view.

### Introduction

Soil factors like availability of nutrients and moisture, soil reaction, microbes, pollutants and factors of the environment like light, temperature, humidity, wind, fire, predators, etc., all affect plant growth. Even near optimal conditions are rare in nature and the plants inevitably suffer from one or the other stress during their life cycle. One such stress, commonly encountered by plants in arid and semi-arid regions is salinity of the soil and water. The salinity hazard of today is mostly man-made, and is largely brought about by the lack of appropriate irrigation management [1]. About a billion hectares of lands have become salt-affected as a consequence, and an additional two million hectares go out of productivity worldwide each year due to secondary salinization [2, 3]. The scarcity of good quality irrigation water coupled with the brackish nature of the underground water and insufficient rainfall causes further soil deterioration.

The current state of affairs suggests that the trend of ever-increasing deterioration of soil and water resources due to salinity is likely to persist at least in the near future, whereas most of our conventional crops have marginal salt tolerance. This necessitates the need to explore alternate options for meeting the challenge. A number of halophytes with potential for use as cash crops could come to our rescue in such a situation. Research has indicated the potential of many halophytes to withstand high soil salinity and saline water irrigation, some even with seawater [4]. This tolerance is achieved through a number of adaptations such as selective uptake and transport of ions, localization of ions in vacuoles, synthesis of compatible organic solutes for cytoplasm balancing and protection of enzyme systems, developing succulence to dilute salt injury, reducing salt load by excretion through specialized salt glands or shedding plant parts, etc. [5]. These plants are hence able to exhibit sustained growth by establishing homeostatic conditions.

Pakistan, with an area of about 800 000 km<sup>2</sup> spans a distance of 1600 km from the Arabian Sea to plains, prairies and playas of temperate northern mountains across deserts. The varied climatic conditions of the country ranging from mild coastal to extremes of hot and cold have created a richly diversified flora of halophytes. A recent survey reports that out of a total of about 2500 halophytic species found worldwide, some 410 are found in Pakistan out of which about 100 are present on the coastal belt of Karachi and the adjoining Balochistan province [6].

### Utilization potential of halophytes

Utilization of *Alhaji maurorum* by the Sumerians as a soil ameliorant is the oldest report on the use of halophytes. However, in recent times the credit goes to the Israelis for rediscovering the halophytes for utilization of saline water and salinized lands [7]. Subsequently, systematic research on the subject gathered momentum during the later half of the last century not only in Israel [8] but also in other countries [1, 3, 5, 9–13] because of the realization that our field crops are generally salt sensitive with a limited potential for improvement of this trait [14]. However, there is increasing evidence in support of utilization of halophytes for various purposes [1, 15]. The problem of salinization has global dimensions and most regions are affected by it to various degrees, although arid and semi-arid areas are the worst affected. Agriculture has so far managed to meet the food demand; however, if the present trends of an increasing population and decreasing crop yields due to salinization continues, it would necessitate remedial measures. It may be too early to predict when we shall start consuming halophytic food, due to our long-established eating preferences, but one thing is pretty certain that the salt sensitivity of our staple food crops will ultimately make them redundant in the future.

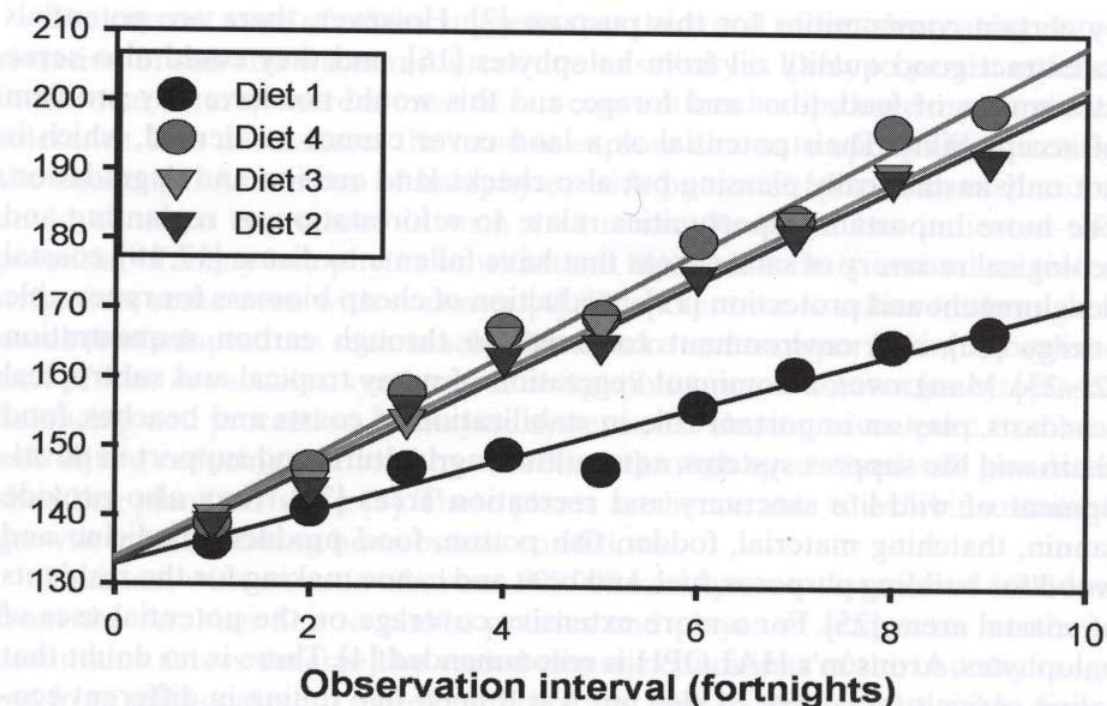
Halophytes are non-conventional crops and it would take a while to make people believe that they represent good food, although some are already used

by certain communities for this purpose [2]. However, there are potentials to extract good quality oil from halophytes [16], and they could also serve as a source of feed, fiber and forage, and this would not have any problem of acceptability. Their potential as a land cover cannot be denied, which is not only aesthetically pleasing but also checks land erosion and degradation. The more important opportunities relate to reforestation or replanting and ecological recovery of saline areas that have fallen into disuse [17, 18], coastal development and protection [19], production of cheap biomass for renewable energy [20], and environment conservation through carbon sequestration [21–23]. Mangroves, a dominant vegetation of many tropical and subtropical seacoasts, play an important role in stabilization of coasts and beaches, food chain and life support systems, aquaculture, agriculture, and support in development of wild-life sanctuary and recreation areas [24]. They also provide tannin, thatching material, fodder, fish poison, food products, medicine and wood for building purposes, fuel, and boat and canoe making for the residents of coastal areas [25]. For a more extensive coverage on the potential uses of halophytes, Aronson's HALOPH is recommended [4]. There is no doubt that saline agriculture is here to stay but it will need fine tuning in different ecological situations.

### Forages and fodders

Capitalizing on the presence of a rich halophytic flora, especially in the coastal areas of Pakistan, the eco-physiology group at the Institute of Sustainable Halophyte Utilization, University of Karachi, has embarked upon an elaborate program of exploring the potential of these plants for use as cash crops. It has been realized that one of the greatest potential of halophytes probably rests in their utilization as forage and fodder [26]. This is particularly relevant for Pakistan, a predominantly agricultural country with serious soil salinity problems, where growing halophytic forages offers the opportunity to reduce the national deficit substantially in forage for livestock. Examples of use of halophytes as forage are found in many countries, e.g., *Haloxylon* and *Kochia* sp. in Iran, *Atriplex* sp. in Argentina and Australia, *Spartina* on the east coast and *Salicornia bigelovii* at the western coast of USA, and planting of halophytes is now a widely accepted option in low rainfall saline regions of Australia and many countries of north Africa to provide valuable fodder reserves when other supplies are exhausted [9–13].

There are about 95 halophytic species that could be used as either forage or fodder. Animals browse most of the halophytic grasses found in Pakistan, which contain variable quantities of fiber and proteins [17]. *Leptochloa fusca*, *Lasarius scindicus*, *Panicum turgidum*, *Dactyloctenium indicum*, *Cynodon dactylon*, *Paspalum vaginatum*, *Sporobolus marginatus*, *S. ioclados*, *Chloris gayana*, *Chloris virgata*, *Echinochloa turnerana*, *Echinochloa colonum* and *Puccinellia distans* are some common grass species found in saline and alka-



**Figure 1.** Effect of different diets on the weight of calves.

line areas and used as forages [6]. Many species of *Alhagi*, *Salicornia*, *Cenopodium*, *Atriplex*, *Salsola*, *Suaeda* and *Kochia* are common fodder shrubs [2]. Among trees, species of *Acacia*, *Prosopis*, *Salvadora* and *Zizyphus* are traditional fodder of arid regions, while on the sea coast, species of mangroves (*Avicennia marina*, *Aegiceras corniculata*, *Ceriops tagal*, *Rhizophora mucronata*) are consumed extensively as forage by camels [20, 24].

A search of local halophytic flora of Sindh/Balochistan seacoast of Pakistan and adjoining areas resulted in the identification of a number of grasses with potential for use as fodder/forage; these were brought to Zia Model Farm, Hub Kund, Balochistan for field testing and further scientific assessment. This farm, situated at 24°57'07.99" N, 66°45'23.74" E has saline soil (EC 10–15 mS/cm) and brackish underground water (EC 15 mS/cm) for irrigation. Based on growth performance under the above-mentioned conditions of the Farm, *Panicum turgidum*, a perennial grass was selected for further testing. It grows well by transplanting root stocks and attains a height of about 1 m in 25–30 days in summer (maximum temperatures generally between 30 and 35°C). However, during the winter months of December to February (minimum 15–18°C) it requires 35–40 days for comparable growth.

An animal feeding trial was conducted at the Farm on 16 young (1 year old) cow calves. The animals were divided into four groups of four and fed a diet containing combinations of traditional (maize) or the halophytic fodder (*Panicum*), while 'concentrates' were omitted from the control treatment. It was observed (Fig. 1) that diets containing maize or *Panicum* were both

equally better than control. A progressive increase in the live weight of all animals was observed during the course of experiment except in the month of August. This coincides with the monsoon rains, which sometime developed muddy conditions in the animal house and, although efforts were made to drain out water as quickly as possible and dry the floor, it seems that the animals were stressed and their growth was hindered during this period. Normal weight gain was, however, subsequently attained. Abdominal fat indicated that meat from animals fed 100% *Panicum* was leaner and hence better for human consumption from health point of view. For confirmation of the results, the experiment will be repeated on a fresh batch of animals.

Considering the acute shortage of fodder in the country, it is encouraging that we have found a suitable grass in the local flora, which can completely replace maize (conventional green fodder) and thus result in considerable savings on its purchase. The halophytic grass is a non-accumulator of salts, which not only improves its acceptability by the animals but it also does away with the additional water requirement caused by the increased thirst of the animals fed high-salt fodder. To the best of our knowledge, few previous studies have looked at big ruminants, especially cow calves, that have been raised entirely on halophytic green fodder, although a number of grazing trials have been conducted on goats and sheep. This work is hence unique in this respect. Efforts are also being made to find a suitable replacement for the dry fodder component of the animal feed to also reduce dependence on this expensive item.

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