

The Economic Feasibility of Firewood Plantation Enterprises in Saudi Arabia

الجدوى الاقتصادية لمشاريع زراعة الحطب في المملكة العربية السعودية

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Abstract: Sustainable management of natural resources has become an indispensable process to combat desertification in arid and semi-arid regions, where lands are dry, natural resources are scarce, and its fragile ecosystems are easily degradable. Ghada (*Haloxylon persicum*) and Ertaa (*Calligonum comosum*) are very important multipurpose indigenous shrubs in the deserts of Saudi Arabia, supplying firewood and fodder to local populations, and have environmental benefits in sand dune fixation and microenvironment improvement. Similar to other desert plants, the population of these two shrubs are badly degraded due to overexploitation. Thus, there is an urgent need for their proper management in order to sustain their productive and protective functions. This paper aims at reviewing and discussing some preliminary findings of investigations carried out in Saudi Arabia on these two desert multipurpose species, and evaluating the economic feasibility of firewood plantation enterprises in Saudi Arabia by applying different discounting and non-discounting economic criteria. Evaluating the economic feasibility for firewood plantation enterprises in Saudi Arabia is made to identify business opportunities to investors and create an incentive to contribute towards protecting the vegetation cover from deterioration by growing both species in the desert of Saudi Arabia commercially, thus, achieving the desired balance to meet high demand for firewood and grazing and to protect the vegetation cover from deterioration. Preliminary findings showed the promising nature of firewood plantations enterprises in Saudi Arabia and their potential role in balancing the high demand for firewood and the conservation of the natural vegetation cover in Saudi Arabia.

Keywords: demand for firewood, plantation, economic feasibility and criteria, natural vegetation cover, Saudi Arabia.

المستخلص: أصبحت الإدارة المستدامة للموارد الطبيعية عملية لا غنى عنها لمكافحة التصحر في المناطق القاحلة وشبه القاحلة، والتي تتصف بأراضيها الجافة، والموارد الطبيعية الشحيحة، والأنظمة البيئية الهشة سريعة التدهور. يعتبر الغضا (*Haloxylon persicum*) والأرطى (*Calligonum comosum*) من الشجيرات المستوطنة الهامة المتعددة الأغراض في صحارى المملكة العربية السعودية ولها أهمية كمصدر للوقود والعلف للسكان المحليين، وتثبيت الكثبان الرملية، وتحسين البيئة الطبيعية. وكغيرها من النباتات الصحراوية ونتيجة للاستغلال المفرط، فقد تدهورت البيئة الطبيعية لشجيرات الغضا والأرطى وأصبحت في حاجة ماسة إلى إدارة سليمة في بيئاتها الطبيعية وبما يضمن وفائها لوظائفها الإنتاجية والوقائية المتعددة بشكل فعال. تهدف هذه الورقة إلى استعراض ومناقشة بعض النتائج التي توصلت إليها دراسة بحثية أجريت في المملكة العربية السعودية على شجيرات الغضا والأرطى، وتقييم الجدوى الاقتصادية لزراعة شجيرات الحطب في المملكة العربية السعودية، باستخدام عدد من المعايير الاقتصادية المخصصة وغير المخصصة. وتأتي أهمية تقييم الجدوى الاقتصادية لزراعة شجيرات

الحطب في المملكة العربية السعودية للتعريف بالفرص الاستثمارية وتحفيز المستثمرين للاستثمار التجاري في زراعة أشجار وشجيرات الحطب في صحارى المملكة والمساهمة في تحقيق التوازن المطلوب بين الطلب المتزايد على الحطب للأغراض المختلفة والحفاظ على الغطاء النباتي من التدهور. لقد أظهرت نتائج الدراسة الطبيعية الواعدة لمشاريع زراعة شجيرات الغضا والأرطى في المملكة العربية السعودية ودور تلك المشاريع في تحقيق التوجهات العامة للمملكة في المحافظة على البيئة الطبيعية والغطاء النباتي الطبيعي من التدهور.

كلمات مدخلية: الطلب على الحطب، استزراع، الجدوى والمعايير الاقتصادية، الغطاء النباتي الطبيعي، المملكة العربية السعودية.

INTRODUCTION

Over the past few decades, increasing emphasis has been placed on promoting plantation of fast growing multipurpose species that produce fuel-wood, timber, fodder, and other forest byproducts, that also stabilize sand dunes, and improve micro environment. However, much of the emphasis on multipurpose trees has focused on exotic species, because more silviculture know-how is known about exotic species than about indigenous species. Nevertheless people continue to use indigenous species as long as they are available. In Saudi Arabia, many populations of Ghada (*Haloxylon persicum* Bunge) and Ertaa (*Calligonum comosum* L'Her.) are not protected and confronted with heavy pressure due to intensive grazing and heavy illicit cutting. Their populations are badly degraded and require rehabilitation and sustainable management.

For any plant rehabilitation program, knowing the methods of propagation and regeneration are essential. The two investigated species, Ghada and Ertaa, are indigenous to Saudi Arabia. They meet local requirements better than exotic species. They grow in a very harsh environment, fix sand dunes, improve the environment, and provide the local populations with fuel and fodder. In regions with increasing desertification in arid and semi arid lands, sustainable development becomes the most important issue. Sustainability is partly a question of technologies or techniques, which must be supported by appropriate policies that reflect the socio – economic needs of the society. Thus the socio –economic impact of sustainability must be analyzed (Wittig, 2003).

This paper aims at reviewing and discussing some findings of investigations carried out in Saudi Arabia on these two desert multipurpose

species (Ghada (*Haloxylon persicum*) and Ertaa (*Calligonum comosum*)), and focusing mainly on evaluating the economic feasibility of firewood plantation enterprises in Saudi Arabia applying different discounting and non-discounting economic criteria. Evaluating the economic feasibility for firewood plantation enterprises in Saudi Arabia is, mainly, to provide an incentive to investors to contribute towards protecting the vegetation cover from deterioration by growing both species in the desert of Saudi Arabia commercially, thus, achieving the desired balance to meet high demand for firewood and grazing on one side and to protect the vegetation cover from deterioration on the other.

MATERIALS AND METHODS

The study relied on certified scientific methods of investigation to evaluate the economic feasibility of firewood plantation enterprise in Saudi Arabia. Primary data were collected from eleven firewood market places in Saudi Arabia representing the average market prices and quantities of firewood.

Experimental plantation of one hectare each was established at Qassim region, Saudi Arabia, one of the natural distribution areas of Ertaa and Ghada. Seedlings for plantation were raised and nurtured as according to Al-Khalifah, *et al.* (2005), Al-Khalifah and Shanavaskhan (2007), and Abdulkader, *et al.* (2008). Irrigation facilities were also provided. Costs incurred for each step were noted separately.

In order to have an account of the natural distribution of these species in Saudi Arabia, based on floristic accounts, plant exploration surveys and herbarium collections, two distribution maps were prepared on LANDSAT images (Figures 1 and 2). A completely randomized design experiment

(CRD) was developed in five natural populations of both species to estimate the productivity in their natural habitat. Three quadrates of 50x50m were marked in each population and

the number of individuals of the species within the quadrate was calculated. Three randomly selected trees were dug out from each population and their fresh and dry weights were recorded.

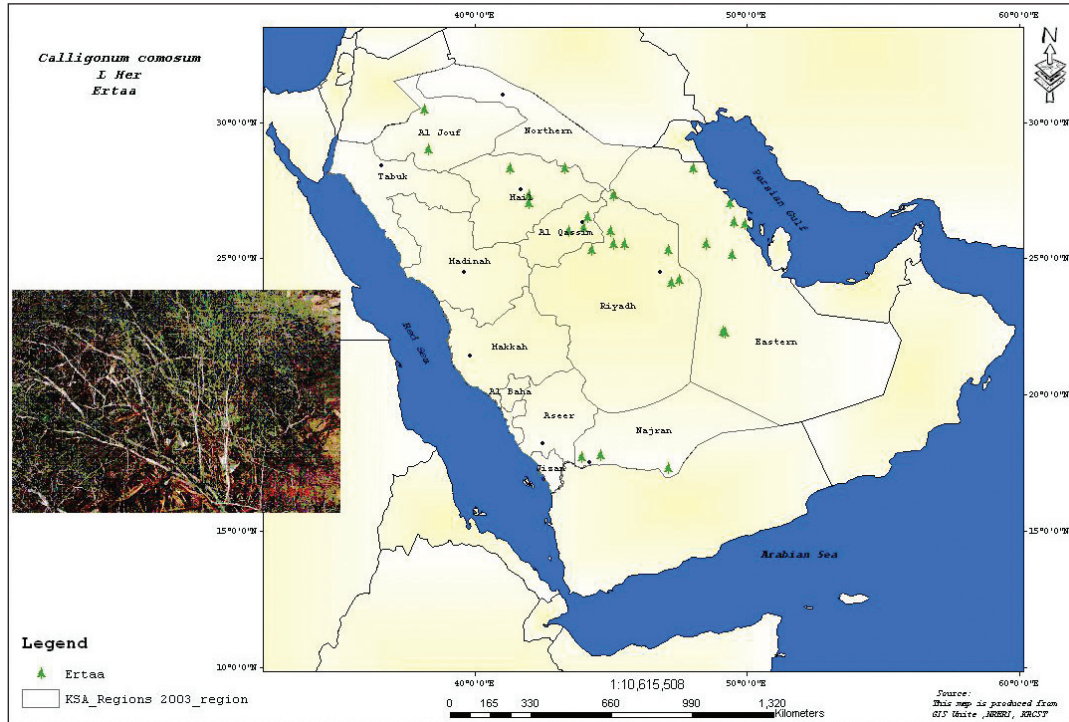


Fig. 1. Natural distribution of Ertaa in Saudi Arabia.

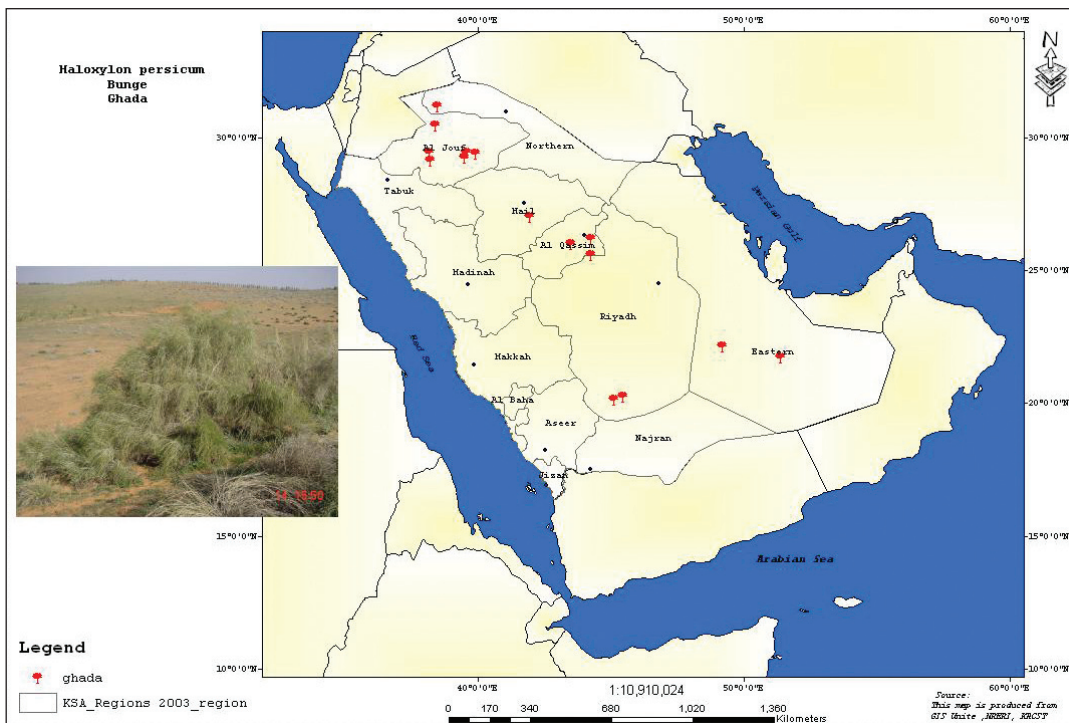


Fig. 2. Natural distribution of Ghada in Saudi Arabia.

Several measures of enterprise profitability were assumed to evaluate the economic feasibility of firewood plantation enterprises in Saudi Arabia, including, Return on Investment (ROI), Pay-back Period (PBP), Net Present Value (NPV), Internal Rate of Return (IRR), and Cost Benefit Ratio (C/B ratio). Each measure provides a valid mean for computing the profitability of a project. Discount rates equivalent to 0%, 1%, 3% were applied to find the present worth of the firewood plantation enterprise, as they are assumed to reflect a reasonable entrepreneur's marginal time preference rate (MTRP) in Saudi Arabia.

The mathematical notations of these measures for the selected greenhouse-grown vegetable crop and the greenhouse tunnel structure alternatives are illustrated as follow (Gittinger, 1982; Schreiner, 1988; Atteah, 2000):

$$NPV = \sum_{t=1}^n \frac{B_t - C_t}{(1+m)^t}$$

$$IRR = \sum_{t=1}^n \frac{B_t - C_t}{(1+m)^t} = 0$$

$$C/B = \sum_{t=1}^n \frac{B_t}{(1+m)^t} + \sum_{t=1}^n \frac{C_t}{(1+m)^t}$$

$$ROI = \sum_{t=1}^n \frac{CF_t}{I_t}$$

$$PBP = \sum_{t=1}^n CF_t - I_t = 0$$

where

NPV = net present value

IRR = internal rate of return

C/B = cost benefit ratio

ROI = return on investment

PBP = pay-back period

B_t = annual incremental benefit

C_t = annual incremental cost

CF_t = incremental net benefit or cash flow

I_t = investments cost

t = 1, 2, ... n years of the project

m = entrepreneur's MTPR or opportunity costs of invested capital equity.

The economic feasibility of firewood plantation enterprises in Saudi Arabia was evaluated based on the following assumptions:

1. One hectare of plantation accommodates 600 seedlings, with 4 meters spacing between the

plants and rows.

2. Nurturing and maintaining seedlings continue for the first three years only from plantation.
3. Death expectancy from planted seedlings is estimated at 25% (Donaldson, *et al.* 1989).
4. Cutting period of firewood plantation is estimated at 5-10 years (Donaldson, *et al.* 1989).
5. Economic age of firewood plantations is estimated as 60 years.

RESULTS AND DISCUSSION

Natural distribution maps of Ertaa (Figure 1) and Ghada (Figure 2) show that the main distribution of these two species is restricted to the sandy areas of Saudi Arabia. Therefore, the selection of Qassim region as experimental plantation site was made. The relative growth rate and estimated biological growth of Ertaa and Ghada using linear and nonlinear functional forms under cultivation was matching reasonably to the natural growth. It was observed that both species attain a considerable size under cultivation and a sustainable harvest can be made at every five years by cutting the main branches 15 cm above the soil, using a sharp hand saw.

Evaluating the economic feasibility of firewood plantation enterprises in Saudi Arabia includes three main components: incremental benefit (*cash inflow*), incremental cost (*cash outflow*) and incremental net benefit (*cash flow*). The incremental benefit (*cash inflow*) reports the value of the produced firewood at the prevailed market prices (Table 1). The incremental cost (*cash outflow*) accounts for all expenses used in the enterprise, including initial costs, operating cost and investment costs. *Initial costs* represent expenses of land preparation, seedling procurement and plantation. *Operating costs* for firewood plantation comprise two items: 1) first stage operation costs, covering all expenses of carrying on the normal production activities in the first three years of plantation such as expenses of irrigation, energy, labor, maintenance and other expenses; and 2) second stage operation costs, covering all expenses of production stage up to the end of project such firewood harvesting, hauling and marketing. *Investment costs* represent, mainly, procurement

cost of irrigation system and water storage tank. Table (2) represents the average annual incremental costs of firewood plantation enterprise in Saudi Arabia. The *incremental net benefit* or cash flow represents the return to the capital resources (equity) put into the enterprise, i.e., the difference between the incremental benefit and the incremental cost.

The economic feasibility study of firewood plantation enterprises in Saudi Arabia showed a reasonable investment return, applying different measures of the economic criteria. Table (3) represents the economic feasibility of Ertaa and Ghada plantation enterprises in Saudi Arabia.

Net present value (NPV) of Ertaa plantation enterprise (EPE) was estimated at 58.67, 32.62 and 3.72 thousand Saudi Riyals per hectare (TSRha⁻¹) at 0%, 1% and 3% discount rates, respectively, which mean that the EPE would

compensate entrepreneur 0%, 1% and 3%, annually and return an additional 58.67, 32.62 and 3.72 TSRha⁻¹ in present value, respectively. Similarly, Net present value (NPV) of Ghada plantation enterprise (GPE) was estimated at 95.95, 59.22 and 18.26 TSRha⁻¹ at 0%, 1% and 3%, respectively, which mean that the GPE would compensate entrepreneur 0%, 1% and 3% annually and return an additional 95.95, 59.22 and 18.26 TSRha⁻¹ in present value, respectively.

Cost benefit ratio (C/B ratio) of EPE was estimated at 1.77, 1.51 and 1.08 at 0%, 1% and 3% discount rates, respectively, whereas C/B ratio was estimated at 2.03, 1.78 and 1.33 for GPE at 0%, 1% and 3% discount rates, respectively. All ratios were greater than one, which means enterprise returning benefits more than the costs. Yet, Ghada plantation is more favorable.

Table 1. Economic indicators of firewood in Saudi Arabia.

Firewood species	Average market prices (SR/ton)	Average market quantities (tons)	Average productivity (tons/ha)	Average Return (SR/ha)
Ertaa	1105.80*	4188.50	2.40	2653.92
Ghada	1017.78*	4623.50	3.36	3419.74

* Significant at $p < 0.01$.

- 1 US \$ = 3.75 Saudi Arabian Riyal (SR)

- Data are calculated from the primary data of this study

Table 2. Average annual incremental costs for Ertaa and Ghada plantation enterprises in Saudi Arabia.

Item	Unit	Ertaa	Ghada
Initial costs	SR/ha	2635.6	2629.6
1st stage operation costs (first three years of plantation)	SR/ha	7159.5	7159.5
2nd stage operation costs (start at production stage up to the end of project)	SR/ton	343	343
Investment costs	SR/ha	14990	14990

- 1 US \$ = 3.75 Saudi Arabian Riyal (SR)

- Data are calculated from the primary data of this study

Table 3. Economic feasibility of Ertaa and Ghada plantation enterprises in Saudi Arabia.

Item	Discounted economic criteria						Undiscounted economic criteria		
	NPV (1000 SR/ha)			C/B ratio			IRR (%)	PBP (year)	ROI (%)
	0%	1%	3%	0%	1%	3%			
Ertaa	58.67	32.62	3.72	1.77	1.51	1.08	3.4	18.8	3.33
Ghada	95.95	59.22	18.26	2.03	1.78	1.33	4.8	15.11	5.44

Internal rate of return (IRR) of EPE was estimated at 3.4% and 4.8% for GPE, implying the maximum discount rate that the EPE and the GPE could pay for the resources used if both enterprises are to recover their investment and operating costs and still break even. Both enterprises are profitable, yet, the GPE is more profitable enterprise in Saudi Arabia.

Payback period economic criteria shows that EPE would cover its investment within 18.8 years from the beginning of the enterprise compared to about 15.1 years for GPE. EPE would generate about 3.33% rate on investment (ROI) compared to about 5.44% RIO for GPE.

CONCLUSION

Demand for firewood is ever increasing in Saudi Arabia and the extra pressure on the firewood market is met from illegal cutting from the limited natural populations. Saudi Arabia is covered with sand in the form of sea sand, which provides ample room for the luxuriant growth of several psammophytes including Ertaa and Ghada. Proper utilization of this vast area is a matter of serious concern for policy makers. Experimental plantation of Ertaa and Ghada in one of the similar habitats has proved that both species can be successfully grown on these comparatively non productive areas of Saudi Arabia. Economic evaluation of these plantations and their market demand also proved that both Ertaa and Ghada can be grown as plantation crops, which provides substantial return to the growers. On the other hand, they help to reduce the extra pressure on natural populations, thereby illicit cuttings can be controlled at certain level. Generally speaking, firewood plantation enterprises are profitable investments in Saudi Arabia, in particular Ghada plantations.

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