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Setting Up *Acacia Ehrenbergiana* (*salam*) plantations in the Tihama Region in the Republic of Yemen

Practical Notes Spate Irrigation

Spate Irrigation Network Yemen

1. Introduction

Indigenous trees are important sources of livelihood for the rural and urban poor communities in the Tihama Plain, the Republic of Yemen. Salam tree (*Acacia ehrenbergiana*) is the most important tree in the region. It produces the best honey, charcoal and *qataran* (a fluid extracted from charcoal and used for curing animal skin diseases). Its thorns and leaves are most liked by livestock: camel, goat and sheep.

This document analyses the economic viability of the *salam* tree. At present, for the first time there is private investment in plantations of *Acacia Ehrenbergiana* in the Tihama region in Yemen, mainly for the production of charcoal and *qataran*, a medicinal fluid. This development may revert the long-time degradation of indigenous tree resources in the region. This paper articulates a business case for such plantations and in general wants to contribute to commercially viable environmental rehabilitation.
The document starts with a brief description of the Tihama region. It then describes the characteristics and uses of *Acacia Ehrenbergiana* and the cost benefits of its cultivation and exploitation.

2. Brief description of the Tihama region

The Republic of Yemen is located in the south-west corner of the Arabian Peninsula and covers a land area of 555,000 km². Yemen has a coast line along the Red Sea called Tihama Plain covering an area of about 22,000 km² with sloping low land around 30-60 km wide. The area is about 400 km long extending along the Red Sea to the west and up to the foot of the mountain in the east. The altitude ranges from sea level to 300 m at the foothills.
The climate of Tihama region is hot, windy and tropical arid to semi-arid. Manthly average temperatures range from 24°C in December-January to 35°C during May- August. Rainfall varies from 50 mm in the arid coastal strip to about 350 mm near the foothills. Relative humidity is still very high, especially during night time and in the morning; it varies from 50% to 70%. Winds generally blow from south-west or north-west, sometimes at high speed causing sand movement and deflation especially on cultivated fields.
The Tihama is mainly a region of deposition starting with gravels and stones near the foothills and ending with fine sands and silts near the coast.
The lowlands of the Tihama plain are crossed by eight Main wadei, namely (from North to South): Hyran, Mawr, Surdud, Siham, Rimaa, Zabied, Nakhla and Ressyan. These wadis collect run-off from east highlands making their way to deeply incised valleys to emerge on the coastal plain, where the water is used for spate irrigation and recharging alluvial aquifers, for domestic water supply and well irrigation.
The natural vegetation in the Tihama region, except on the coast near salt pans, is dominated by different dwarf-shrubs such as *Suaeda fructicosa*, *Odyssa mucronata*, *Leptadonia pyrotechnica* and *Panicum targidum* and by different indigenous trees such as *Acacia ehrenbergiana, A. tortilis*, *Salvadora persica*, *Tamarix spp hyphaene thbaica. zizyphus*, *Planets aeygeptica*.
Today most of local indigenous trees are gone due to establishment of new cultivated lands, and much of Tihama area is cultivated either by Wadi flood irrigation or by modern pump irrigation. After heavy rainfall even sterile looking sand dunes are cultivated with millet cereals crop called Dokhn (*Pennisetum americanum*) and various local beans. In regularly irrigated areas, many plants are cultivated. These include cereals (millet, different local sorghum species and maize) and vegetables (tomatoes, onion, beans, okra, cucumber, squash, water melons and sweet melons); fruit trees (mango, date palm, banana, papaya, guava and figs) and technical crops (cotton, tobacco and sesame).

Figure 1 and 2 Some *salam* area has vanished due to new bump irrigation cultivated farms.

3. Characteristics of Tihama Salam tree (*Acacia ehrenbergiana*)

There are many blocks of woodland in the Tihama region dominated by *Acacia ehrenbergiana*. The tree grows in the eastern Tihama about 20 km from the Red Sea between Wadi Mawr and Wadi Zabied on alluvial sands and silt. The woodland is used for fuel wood, and as a range land for goats, sheep and camels. The ground cover of *Acacia ehrenbergiana* is usually minimal due to grazing, establishment of new agricultural farms and cutting for charcoal production. Regeneration of *salam* tree (*Acacia ehrenbergiana*) can be a good option if there is no overgrazing. Traditionally, *A. ehrenbergiana* re-grows from cut stumps, but it can also be propagated using seeds mixed with animal (goat and sheep) manure. Acacia seeds eaten by animals usually have a better germination than broad cast seed. *Acacia ehrenbergiana* is one of the most drought-tolerant of the common African acacias occurring in belts that get about 50-300 mm rainfall.

Figure 3 Common community area in Tihama *Acacia ehrenbergiana* associated with *Hypaene thebaice*.

3.1 Botanic description

Salam trees (*Acacia ehrenbergiana*) are multi-stemmed and spreading from the base, 2-7 m. The growing young trees form a lower canopy. Slash green outside and red inside. Leaves are small with 1-2 pairs of pinnae, each with 8-12 pairs of leaflets. Thorns are 4-6 cm long, with, straight, set out in axillaries pairs, longer than the neighboring leaves. Flowers globosely gold-yellow in 1.0-1.5 cm diameter heads. Pods are narrow to linear 7-10 cm long, more or less curved, falcate and twisted, bright-red when young. Seed is small 4-6 mm long, 2-3 mm width, it has splay shape and dark brown color.

Figure 4 Leaves, flowers and buds of *Acacia ehrenbergiana*.

3.2 Maturity of Salam tree (*A. ehrenbergiana*)

The *salam* tree can mature when 2-3 years old, that is when the flowers and buds appear. During this period, the *salam* plantation can be used for bee-feeding and producing *salam* honey, the premier quality honey in Tihama. For high quality charcoal production, the *salam* tree must be more than 6 year old.

3.3 Production of seedlings

For purposes of forestation and sand dune stabilization in the Tihama region, the local Agricultural Department of the government grows *salam* tree seedlings in 50% shaded nurseries in polythene bags filled with mixed soil (25% sand and 75% clay). The sowing period of *salam* is July-December. The seed germinates during 3-6 days after sowing. The seedlings are kept in nursery till they are 4-6 month old and have a 40-50 cm stem height. After that, the seedlings are transferred to permanent fields.
Seedlings are distributed through the agricultural department free-of-charge, especially for cultivated farms affected by sand dunes movements. Other cultivated lands where *salam* trees are used as shelterbelts, get seedlings at government supported prices ranging from 20 to 50 YR (0.1 - 0.25 USD). *Salam* trees are usually randomly spaced, grown about 5 meters from each other. In the nursery they should be irrigated every 3-7 days, depending on air temperature, with a quantity 270- 400 cm^3.
In permanent fields the irrigation of *salam* trees must take place at 15-20 days interval during the first year. In the second year, they should be irrigated once a month. After that, the *salam* tree is self dependend. The growth of trees then depend on the rainy season.

4 Products and main uses of Salam trees in Tihama

4.1 Firewood

Cut stems with leaves are used by farmer's housekeepers as firewood.

4.2 Animal and bee feeding

Most of *salam* plantations in Tihama are used as range land for feeding sheep, goats, and camels. *Acacia ehrenbergiana* is classified as a Legminosae. Its leaves and buds are rich in nitrogen and considered to be good as animal fodder (especially for goats).

4.3 Charcoal production

In the Tihama area, where the plantations of *salam* trees occur, farmers produce charcoal as a cash product by cutting old and some young *salam* trees. The charcoal product is mainly used for smoking pipes and as a fuel in cooking some traditional Tihama food dishes and bread.

4.5 Liquid medicine called *qataran*

Qataran is a black colored liquid. There are two kinds of *qataran* extracted from *salam* trees:

1. A thin and watery fluid. It is used as an animal medicine, in the treatment of insect and fungi parasites (lice, tick, and scabies) especially for camels. The fluid is also used in the treatment of human skin diseases caused by parasites, especially on the scalp.
2. A heavy and thick fluid. This type of *qataran* has a nice strong smell. It is used for painting wooden cups and preserving them. It is used for other painting-related purposes as well, including painting of wooden ceilings and wooden furniture to protect them from insects, especially termites. The heavy *qataran* fluid is also applied on the stems of fruit trees to protect them from insects and fungi.

4.5 Production of the highquality *salam* honey

During the flowering period (from February to April) of the *salam* tree (*Acacia ehrenbergiana*), beekeepers transfer their beehives from different sites to the *salam* area to feed the bees. *Salam* flowers are much preferred by bees. In Yemen, *salam* honey is considered to be of a high quality and is used in traditional dishes ("*Bit-Alsahen*", "*Fatta*"). *Salam* honey costs about USD 30/litre.

Figure 5 Camels feeding on *salam* trees.

Figure 6 Bees feeding on *salam* trees.

Figure 7 Interviewing a *qataran* manufaturer. In front of him: *qataran* fluid.

Figure 8 Beekeepers shift their bee hives to *salam* areas during flowering period.

Box 1: Steps of charcoal production

1. Cutting the stems & trimming leaves and small branches

2. Removal of thorns by controlled burning

3. Piled stems

4. Covering the stem-pile by iron plate

5. Covering the stem-pile by animal sorghum residues

6. Cover the stem-pile with clay soil

7. Ignite the pile through 1-2 small openings

8. Openings

9. Openings

10. Charcoal bags

11. Final charcoal products

12 Interview with a charcoal producer

5 Processing procedures of major Salam product

5.1 Steps of charcoal production (see box 1)

1. Cut all *salam* tree's stems, with a sharp axe.
2. Trim the leaves and small branches.
3. Burn the stems lightly in a controlled manner, to remove thorns.
4. Pile thorn-free stems in a good organized order.
5. Cover the organized, piled-up wood with iron metal plates from above to prevent quick burning and for extracting the *qataran* (thin and watery fluid), then cover the other sides of the pile with upper small branches of a *salam* tree.
6. Cover the metal plate and piled wood with sorghum residues (left over by animal) mixed with animal manure and then cover the pile with silt- clay soil
7. Ignite the sorghum residues through 1 to 3 small opening in the pile.
8. Let the pile burn for 8-10 days, then close the openings with soil, allow three days for cooling.
9. Extract the piled wood, break them down and pack them in sacks 15-20 kg weight. Charcoal sold on site or delivered to towns market.

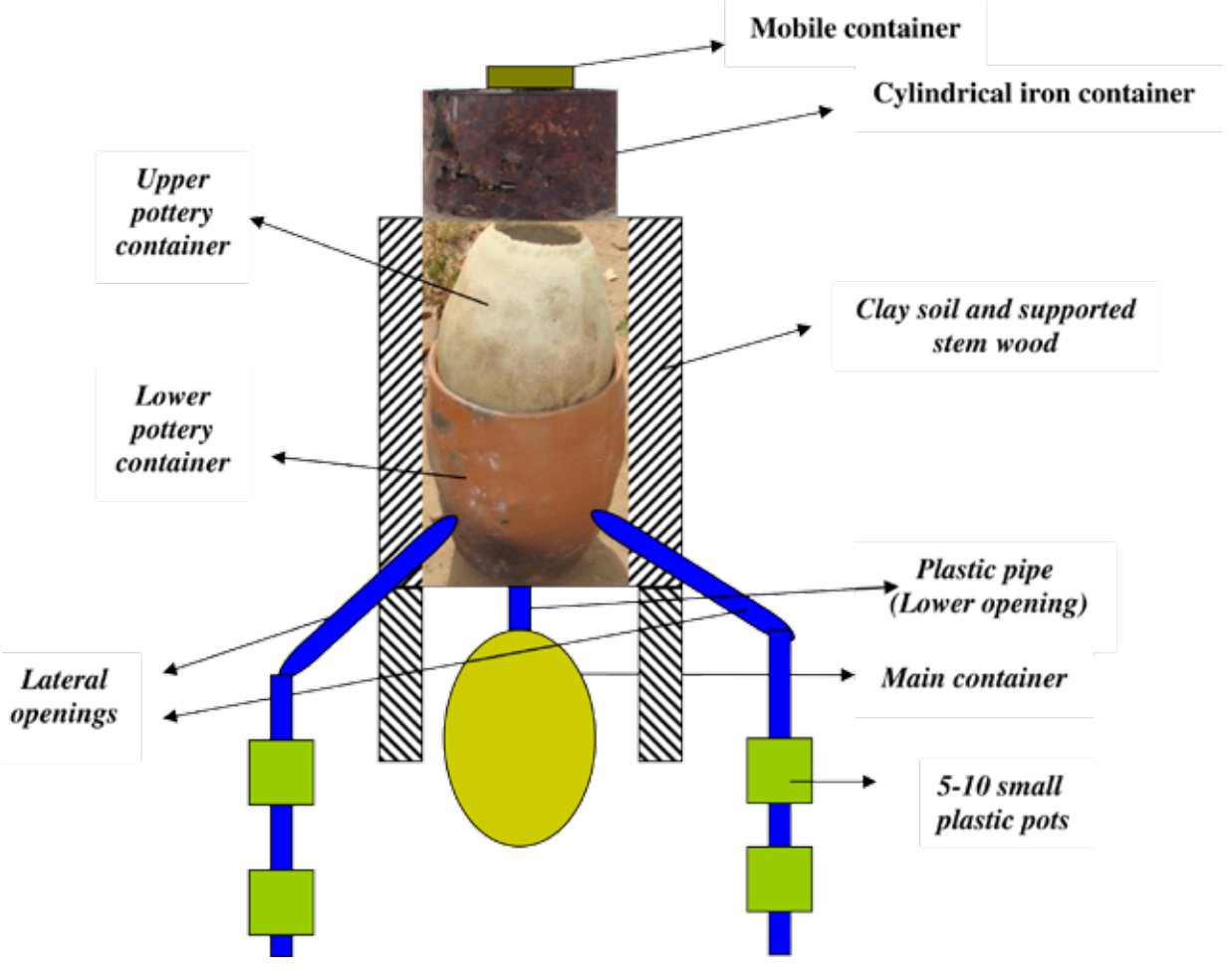

Figure 11 Schematic overview of the *qataran* extracion device

5.2 Methods of *qataran* extraction

5.2.1 Thin and watery fluid

During the processes of charcoal production, the thin, watery *qataran* is extracted after three days of igniting. It can be collected by inserting a metal pipe under the iron sheet through the opening.

5.2.2 Heavy and thick fluid

The thick *qataran* (and also the thin *qataran*) is extracted by simple, traditional methods, using extraction devices made out of available local resources.

The extraction device consists of an oven (i), 1 main plastic container (ii), 5-10 plastic containers (iii), mobile metal container (iv) and animal manure (v).

i. The oven is located at a higher level than the lateral containers and rubber pipes. The oven consists of:

- Two conical pottery containers - upper and lower fitted together. The upper one has one opening on top (12-15 cm diameter) and is fully opened from the cone base. The lower one is connected from the top with the upper one; it has a circular center with a 40-70 cm diameter and two lateral small openings of 2-3 cm diamete. It also has a third opening in the bottom. All two pottery containers are covered with clay soil supported with woods.
- Iron container with a cylindrical shape of 75-100 cm diameter. It is located on the top of the oven.

ii. The main plastic container is located directly under the oven and is connected with the bottom of the oven by a rubber pipe.

iii. 5-10 plastic containers or pots of 10-20 litre capacity are connected to each other with rubber pipes located in the right and left sides of the oven.

iv. A mobile square iron metal container, where the *salam* wood pieces are collected. It has a circular opening with a12-15 cm diameter. (it has the same diameter of the upper pottery containers)

v. Animal (cow) manure is used for slow burning.

5.3 The processing of *qataran* extraction,

Figure 10 Typical *qataran* extracion device.

implemented in the extraction device.

1. Cut the *salam* tree stems in to small pieces and collect them in the mobile iron container. Cover it with a small iron square plate with a small opening at the center.
2. Put the mobile container with the collected small wood pieces inside the iron cylinder above the oven. The opening of container should be downwards.
3. Put the manure into the cylindrical container (around the mobile container above the oven) and ignite it.
4. The indirect heating of the small pieces of wood inside the mobile container produces steam and ultimately a black liquid locally called *qataran*.

This liquid makes its way into the pottery container and eventually through the plastic pipes into the final collection sinks - the main container and the smaller containers (figure 11). The liquid collected close to the outlet of the pottery container is thick and viscous - it is used exclusively to cure skin diseases in camels - one liter is considered sufficient to apply on one adult camel. The relatively diluted liquid harvested far from the outlet of the clay container is primarly used for curing skin disease of goats. As common practice about a quarter of a litre is perscribed to a fully grown goat.

6. Cost-benefit analyses of charcoal production

Energy security is an increasing concern globally. Often this concern is associated with the long term availability of fossil fuels, summarized in the discussion on 'peak oil'. Biomass in many countries constitutes a major source of energy - serving remote and often poor rural and urban population. With the incessant degradation of forest and brushwood resources - not just in large forest areas but scattered all over - the importance of commercial local biomass production is very high.

In Tihama, the density of *salam* cultivation has decreased from 300-500 trees/ha in 20 years to 150-250 trees/ha. The farmers managing charcoal production usually purchase *salam* trees by blocks of 0.5-1.0 maad area (3600 m²). The average price of land is 100,000 YR per maad. After charcoal processing, one maad produces about 300 bags (25 kg) of charcoal, and one bag costs 1500 YR in the field.

There are two cases to calculate cost-benefit analyses of Charcoal Production.
Case 1: The villagers dealing with charcoal production usually buy a block of *salam* tree and pay some workers under their supervision to do several processes of charcoal production. The wages of laborers range from 500 YR to 700 YR.

Case 2: The *salam* tree plantation owner (buyer) enters into a cost benefit sharing arrangement with a group of local workers that have the necessary experience in charcoal production. The owner (buyer) provides all material required while the workers invest the labour needed to undertake all the steps leading upto the final production of charcoal. The owner usually claims 75% of the charcoal production either in kind or cash and the rest 25% goes to the workers.

Case 1
Expenditure:

1. The cost of one maad area (3600m²) of Salam trees = 100,000 YR (500 USD)
2. Cutting of stems; this process need 15 skilled workers for seven working days.
   Wage per day = 700 YR
   Cost of cutting = 15 labors × 7 days {105 m/day} × 700 YR = 73,500 YR (367.5 USD).
3. Cleaning stems; (trimming leaves and small branches, controlled torn burning, and piling wood)
   This process needs four workers over 20 working days.
   Wage per day = 500YR
   Cost of cleaning stems = 4 worker × 20 day {80 m/day} × 500YR = 40,000YR (200 USD)
4. Removal of cut stumps;
   This process is usually done by tenancy a heavy Removal machine, one maad area takes in average 1.5 hour, one hour working machine costs 4000YR.
   Cost of cut-stump removal = 1.0 hour × 4000 = 4,000YR (20 USD)
5. Packaging and Transportation:
   = 10,000YR (50 USD)

Total expenditure:
100,000 + 73,500 + 40,000 + 4,000 + 10,000 = 227,500 YR (1,137.5 USD)

Total income:
Total price of Charcoal production from one Maad area = 300 bags × 1300YR = 390,000 YR (1,950 USD)

Net benefit:
= 390,000 – 227,500 = 162,500 YR (812.5 USD)

Case2
Expenditure:
Price per maad of area under *salam* cultivation (3600m²) = 100,000 YR (500 USD)
Percentage amount of Group Workers 30% =117,000 YR (585 USD)
Total cost = 100,000 + 117,000 = 217,000 YR (1085 USD)

Total income:
Total price of Charcoal production from one maad area
= 300 bags × 1300YR = 390,000 YR (1,950 USD)

Net benefit:
390,000 YR - 217,000 YR = 173000 YR (865 USD).

7. Cost-benefit analyses of *qataran* product

Villagers who live around the *salam* wood-lands, are the ones who undertake *qataran* production. They usually obtain wood from tree-owners around the *salam*-cultivated areas.
A big multi-stem tree, more than 10 years old and containing many stems (more than 15 stems) with 12 cm diameter and more; costs about 10,000 YR (50 USD). A small tree, around 7 years old or less costs 2,000 – 5,000 YR (10 – 25 USD).
The big tree is cut into small pieces that are placed in nearly 50 mobile cubic containers (24 cm × 24 cm × 36 cm). Each cubic container produces two liters *qataran* fluid, and each litre of *qataran* costs around 200 YR (1 USD).

Outgoing expenditure:

1. The cost of one big Salam tree = 10,000YR (50USD).
2. Cost of cleaning and cutting tree to small pieces wood = 1000 YR (5 USD)

Total Outgoing expenditure:

10,000 YR + 1000 YR = 11,000 YR (55 USD)

The total income:
50 container × 2 liter × 200YR = 20,000YR (50USD).

The total benefit:
20,000YR – 10,000YR = 11,000YR (45,0000USD)

Box 2: Structure of *qataran* extraction device

Lower pottery container

Upper pottery container

Upper & lower pottery container fitted together

Button of lower Pottery container

Upper cylindrical container (place 0f burning action)

Mobile container

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