The Importance of *Ziziphus spina-christi* in the Drylands with Reference to Yemen

Elsiddig[1], E. A., Luukkanen[2], O., Batahir[3], A. S. and Elfadl[4], M. A.

Elnour Abdalla Elsiddig[1] University of Khartoum, Faculty of Forestry, Sudan[5]

Olavi Luukkanen[2] Viikki Tropical Resources Inistitute (VITRI)

Ahmed Salim Batahir[3] Agricultural Research Station, Seiun, Yemen

Mohamed Ahmed Elfadl[4] Viikki Tropical Resources Institute (VITRI)

University of Khartoum /Faculty of Forestry /Shambat /Sudan5

E-mail elnour_elsiddig@yahoo.com

Abstract: The study reviews some characteristics of *Ziziphus spina*-christi species in relation to its ecological distribution along its range of occurrence in drylands and attempts to describe and evaluate its role in stability, productivity and sustainability of the traditional agroforestry in Yemen. The wide range of benefits that the species provides, including timber and non-timber products are presented taking Yemen as a case. The history of the species relationship with farmers in Wadi Hadhramout is related to the rotation management system adopted by farmers. Special interest is focussed on the management of the species on farmland in Wadi Hadhramout, in Yemen, where it contributes to farmer's income and to farm sustainable production. The adoption of multiple purpose management objectives is shown. The impact of the agroforestry system in Wadi

Hadhramout on bio-diversity is indicated. On farm research as collaboration between farmers and research groups is discussed and highlights on future research needs stated.

Introduction

Ziziphus spina-christi (L.) Desf; *belongs* to the familiy Rhammaceae. The species common name includes Christ-thorn, Ber and Kurna. In Arabic it is named nabbag and sidr. *Ziziphus spina-christi* is the famous known important species in the genus *Ziziphus* that includes other five important species: *Z. mauritiana, Z. jujuba, Z. rotidifilia, Z. rugosa and Z. vulgaris* (ElAmin 1990).

Ziziphus spina-christi is evergreen, spiny shrub to a small or medium sized tree 3-10 metre high and up to 45 cm in diameter at root collar (Bailey 1947). It has dense, widely spreading slender branches, bearing many short, curved spines forming impenetrable thickets in river beds (Hutchinson and Dalziel 1958). The bole of the tree is very short, branching at low height and in some cases at ground level (NAS 1980). The bark is brownish grey and roughly fissured. The leaves are simple, alternate evergreen.

Z. spina-christi flowers between August and December. The flowers are dense, up to 1.25-cm long very small and greenish yellow in color. The species fruits between October and January. *Z. spina-christi* is characterized by extraordinary regenerative power. The species establishes itself naturally by seeds or coppice (ICUC 2001). It is vegetativeiy established by cuttings and suckering. Soaking in water enhances quick germination. Animals feed on *Z. spina-christi* fruits and seeds. The seeds pass through the animal's digestive track where naturally treated and come out in the animals faeces ready for germination. Farmers in Yemen use these seeds for establishment of *Z.spina-christi* belts

along canals and farm boundaries (Al-yousfi 1997). Sidr was found coppicing, in large number of shoots on old stumps of trees growing in the farms, shortly after tree felling.

Z. spina-christi is extremely resistant to heat, drought and fires. It develops long, deep taproot, that facilitates its ability to reach deep water levels and this may justify its evergreen habit and ability to withstand drought. It grows in desert areas, with about 100 - 400 mm rainfall per annum, and can grow in less arid areas and tolerates a very wide range of soil types, including alluvial plains characterized by deep soils (Vashishtha 1997). It grows best in depressions, Wadis and riverbeds where ground water is available.

Z. spina-christi is distributed in a wide ecological range in dry tropical regions, Sahara and Sahel (Cherry 1985, Maydell 1986, Vashishtha 1997, Pareek 2001). It is native to a wide area in Africa from Mauritania through the Sahelian Zone to Red Sea, growing naturally in 16 African countries (NAS 1980). Sidr is also native to a wide area in Asia distributed from eastern Mediterranean, eastern Turkey to the Arabian Peninsula and Iran, occurring naturally in 13 Asian countries (Hubeishi and Hohenstein 1984; Batheib 1991; Scholte *et al* 1991).

Sidr is found almost everywhere in Yemen from coastal plain to highlands (Hubaishi and Hohenstein 1984). The species grows along an altitudinal range up to 2000 m.a.s.1.(Webb *et al* 1984, Ottoman *et al* 1989). Of the 245 trees, shrubs and herbs species surveyed and identified in Yemen, by Hubaishi and Hohenstein (1984), *Z. spina-christi* is the only tree species recorded to occur throughout the six identified natural regions: Tihama coastal plain, Tihama Foothills, Lower Escarpment, Higher Escarpment, Highland and High Mountains, semidesert and desert. Only five

other plant species (shrubs and perennial plants) are identified to occur on these six natural regions of Yemen together with *Z. spina-chriti* (Hubaishi and Hohenstein 1984).

Ziziphus spina-christi is a component of the natural vegetation composition of the six topographic regions of Yemen in natural form and in an agroforestry system (Hubeishi and Hohenstein 1984). Of the 2.4 million hectares (ha) of forestlands in Yemen surveyed by Hunting Technical service (1991), only 0.4 million hectares qualify as agroforestry system in which *Z. spina-christi* is the main tree component (Al-Yousfi 1997*). Z. spina-christi* is the most important tree species among the forest trees communities of the natural vegetation in Wadi Hadhramout .

Materials and Methods

The present study used the inventory and the questionnaire data available at the General Directorate of Forestry and Desertification Control in Yemen. The data included previous inventories conducted in Yemen by projects including the GTZ (1984) and Hunting Technical Service (1991) and Wadi Hadhramout Agricultural Research Station. The inventory and questionnaire conducted along Wadi Hadhramout constituted the main data in which individual tree species data were collected using sample plot procedure (Elsiddig 1980). Equidistant 0.25 hectare sample plots were distributed at 300 metre along equidistant parallel survey lines laid from upper slope of Wadi Hadhramout towards Wadi bottom, at 500 metre between the lines. In addition, farmer's questionnaires were obtained where the target group included farmer and key informants in Wadi Hadhramout. Review of literature about the species distribution in drylands was also considered.

Results and Discussion

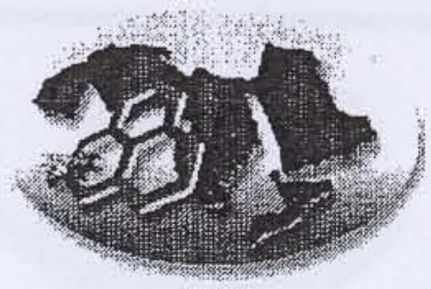
Uses and Benefits

Indigenous products of *Z. spina-christi* tree are important assets to the Yemani people as it provides them with food (fruits and honey), wood, fodder, material for handicrafts and non-wood products. For most of the people the species also provides an important source of income from sales of honey and wood. The honey of *Z. spinachristi* is characterized by the best quality for export. Women collect and dry the leaves that they use as shampoo.

The use of *Z. spina-christi* wood as poles in Wadi Hadhramout is indicated by 90% of the respondents. The use of the species wood was long known inYemen as indicated by the wood found at the ruins of Ribbon city and the old temples walls (YCRCA and ASSU 1984; Al-Subban 1985).

The famous historical buildings of Shibam and other towns of Wadi Hadhramout have *Z. spina-christi* poles as major components of their roofs. The wood is used for spear shafts, posts, roofing beams and household utensils and for cabinet manufacture. The use of *Z. spina-christi* wood for fuel is confirmed by 90% of the respondents and this is in line with the National Academy of science (NAS 1980) statement that wherever *Z. spina-christi* grows, it is used for fuel. The red or dark-brown wood is hard and dense and burns with an intense heat.

Yemani farmers and herders use the fruits and foliage of Z. spina- Christi for animal feed (Alyousfi 1997, Elsiddig and Bataher 2003). Sheep and goats generally eat the



fruits of Z.spina-christi and the camel and other livestock eat the foliage, at the time of scarcity, as indicated by key informants in Hadhramout and Tihama regions.

The branches are used for fencing (Maydell 1986; Al-yousfi 1997). Medicinal material is reported to be used by few people in the area (20 - 30% in Wadi Hadhramout). Medicinal material is obtained from the tree by local people and used against snakebite and other poisons as indicated by key informants. Different parts of *Z. spina-christi* are reported to have medicinal value used by African,

Egyptian and Saudi Arabian people (Al-Akeely 1985; Abdul-Galil and El-Jissary 1991). Bedouins use *Z. spina-christi* as a medicine for animal birth control (Shappira *el al*. 1990).

Z. spina-christi is an important tree species as a component of the farming system in Yeman. Farmers preferred the species because of the wide range of uses and benefits it provides. Results of farmers' questionnaire conducted in different parts of Yeman indicate that 85 –90% of farmers in Wadi Hadrhramout (Elsiddig and Bataher 2003) and 50 – 60% in Tihama (Alyousfi 1997) perceive the various benefits and services of *Z. spina-christi.*

Farmers are aware about the protective role of *Z. spina-christi* in Wadi Hadhramout, where 70%, 50% and 40% of respondents indicated the role of the species in checking floods, in soil erosion control and in soil improvement respectively. Because of its protective role, the species is used on farms as windbreak in the Highlands of central Yemen (Al-Yousfi 2001) and in desert prone areas in Lahg region (Almualim 1998). Many authors (Webb et al 1984; Von Carlowitz 1986, 1997;

Young 1989) confirm the important role of *Z. spina-christi* for soil improvement in agroforestry systems. The species is included in the list of 68 principal trees and shrubs that have been employed for soil improvement (Young 1989; MacDickens 1991). Alriksson and Ohlsson (1990) stated that trees are integrated with agricultural crops or livestock in varying ways and managed for various

uses in Yeman. With its diversified uses and benefits, *Z. spina-christi* agroforestry system is qualified to fit in the definition stated by Leakey 1996 that agroforestry is a dynamic, ecologically based, natural resource management system that through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels.

Management

Farmers in Yeman developed and maintained *Z. spina-christi* in agroforestry systems as parklands over long rotation periods. Forest and farm management is basically related to *Z. spina-christi* managed over a long rotation extending over 150 years (Table 1). The species *is* known to be very vigorously coppicing and may continue to coppice up to ten times over the rotation. The length of successive periods between coppices depends on the stem size-classes to be harvested and the market requirements.

Table 2. Age and rotation periods of *Z.spina-christi* coppice on different farms

0n different regions in Yeman.

rotation years	Farm area of fellings	Number length, years	Stump age hectare	Number of farms
8-9	5-10		6-7	50-60 3
	20-35	3-6	4-9 40-70	6
	7-8	6-10	2-3 15-25	4
10-12	4-10		3-8 30-100	2
7-12	4-12		4-6 30-70	5
10-11	3-8		6-12 60-130	4
10-12	4-10		2- 3 25-30	3
10	6-10		4-10 40-100	6

The most important products of *Z. spina-chrisli* are the food (fruits and honey), fodder timber and fuel in addition to the protective role. On-farm trees are managed for harvesting of these products planned to take place at suitable seasons during the year. Farmers select the marketable size of poles (Elsiddig and Bataher 2003) and control the felling of stems on short periods over the stump age (El-Yousfi 1997). They choose the suitable felling season according to valid reasons (Table 2). For the majority of farmers interviewed in the different farms surveyed, (75 - 92%), winter is the most appropriate felling season (Table 2).

Table 3: Farmers responses and dstribution percent with respect to the choice of winter season for felling *Z.spina-christi*

% distribution of farmers Hadhramout	% distribution of farmers Tihama	Felling season
75	92	Winter felling
8	25	According to need
100	100	Total

Source: El-Yousfi 1997; Bataher 1998

Note: N = 40 farmers

Felling is executed during December-January based on farmer's belief that the poles of Sidr produced off winter season are not durable as those felled in winter. Felling is not practiced on *Z.*

spina-christi during the flowering season (October -November)main production season of the best quality honey (NAP 1990). Honey production is the major activity and the honeybee hyves are carefully managed during this period.

The adoption of selection system indicates that the trees are sustainably maintained on farm.

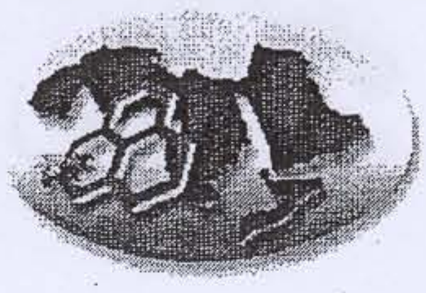
Farmers in Yeman inherited efficient and successful farming system of integrated trees and crops in simultaneous co-existence. Farmers aquired good experience in management and felling control of *Z.spina-christi*. Their local knowledge about tree management and silvicultural techniques maintained the existence of *Z. spina-christi* with crops for over two hundred years (YCRCA and ASSU 1984). The system also sustains agricultural cropping, with date palm, fruit trees and livestock keeping besides the other benefits as shelter, shade and environmental protection.

On-farm establishment techniques of *Z. spina-christi* are well known to Yemani farmers. Various methods are adopted including natural regeneration protection, treated seeds sowing and seedling planting (Al-Yousfi 1997; Bataher 1998; Elmualim 1998). *Z. spina-christi* is found in various spatial arrangement in scatter trees forming agroforestry parklands (Al-Khuleidi ; Elsiddig and Bataher 2003) and in shelterbelts along farm boundaries and along internal irrigation canals (Almualim 1998; Elsiddig and Bataher 2003). Sometimes woodlots of *Z. spina*-christi are established on high contour area inside farms(Elsiddig and Bataher 2003). The productivity of *Z. spina-christi* in wood, fruits and leaves is widely variable. Farmers in the different regions of Yemen observe variations in fruit size, taste and time of ripening. Farmers are not aware about the importance of selection and tree improvement when they establish the tree by natural regeneration or planting. They gather animal-treated seeds or transplant seedling from inside their farms without being concerned with the quality. Research and technology transfer is needed for tree improvement.

Elsewhere, *Z. spina-christi* has received some progress with respect to domestication and tree improvement. Yield quality and quantity improvement has been achieved by selection of scions from high yielding varieties grafted on vigorous rootstocks of *Z spina-christi* (Cherry 1985; Charfas 1989). Rootstock seedlings are raised in the nursery in polythene tubes in a large-scale multiplication to provide the source of the rootstock for grafting (Vashishtha 1997; ICUC 2001). The commercial cultivars that are clonally propagated, via budding, by grafting on rootstock, retain their genetic fidelity (Arndt 2001). However, the natural population of *Z. spina-christi* and the other species of the genus which largely regenerate through seeds exibit vast range of genetic variability which has been very much underutilized (Arndt 2001). Selection for tree improvement may get use of the variation. The approach of good quality cultivar selection and grafting is a technique used in agroforestry tree domestication and production improvement.

Impact on biodiversity

Table 4 shows that the agroforestry system practiced in Wadi Hadhramout is in favor of *Z. spina-christi* but showed a negative impact on the bio-diversity. In this respect, three zones are identified showing different population densities and distinct agro-ecological conditions as from upper slopes of the Wadi to bottom (Table 4). *Acacia tortilis (*the dominant species), *Z. leucodermis* and other lesser species (*Acacia ehrenbergiana, A. melifera, Maerua crassifolia, Moriga perigrina* and *Pithocelobia dulce*) in Wadi Hadhramout exhibit decreasing trends in number and distribution as from upper slopes towards Wadi bottom while the number of *Z. spina-christi is* increasing. The distribution (frequency) of *Z. spina-christi*, measured as the number of plots in which the species occurred expressed as percent of total number of plots measured is also increasing. The upper



slopes are predominantly covered with natural forests while in the lower zone extensive agriculture is practiced.

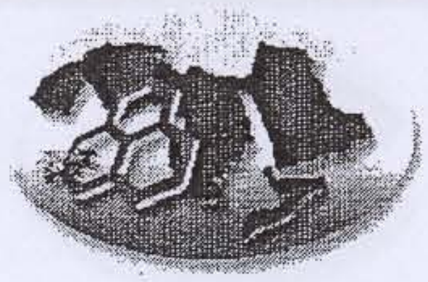
Table 4 shows that in the upper zone, *A. tortilis* is found in 16 out of 17 plots, resulting in 94% frequency distribution and a density of 114 trees per hectare. However, in the lower zone *A. tortilis* frequency distribution is limited to 4 out of 19 plots resulting in 21% frequency distribution. However, its density is 139 trees per hectare which may indicate that *A. tortilis* is existing in natural dense small pockets constituting of-farm vegetation in the lower agricultural zone. Other species found in association with *A. tortilis* include *A. ehrenbergian, A. melifera, Maerua crassifolia, Moriga perigrina* and *Pithocelobia dulce* (the lesser species). The on-farm tree composition is predominately of *Z. spina-christi.*

Table 4. Distribution and frequency of individual tree species along three Zones of Wadi Hadhramout.

Zones	number of plot	species	Total trees Per plots	plots where species occur	density per Ha.	frequency %	
A.t	456	16	130	94.0	17	Upper zone	
(Natural		*Z.l*	21	7	12	41.2	
forests)		*Z.s*	22	5	17.6	29.0	
70.4	29.0		5	88	*A.e*		
Middle zone	16	*A.t*	508	14	145	8	
(Limited		*Z.l*	5	4	5	25.0	
		Z.s	91	10	36.4	62.5	cultivation)
90	7	51.5	43.8	*A.e*			
A.t	139	4	139	21.0		19 Lower zone	
(Extensive		*Z.l*	1	1	4	5.3	
Cultivation		*Z.s*	90	15	24	79.0	
7	35.4	36.8	*A.e*	62			

A.t = A. tortilis ; Z. l = Z. leucodermis ; Z.s = Z. spina-christi ; A.e = A. ehrenbergiana

It is stated in the literature that farming on natural parklands in the drylands reduces the number and distribution of the tree species composing the natural structure. Trees preferred by farmers are retained while others are removed (Radwanski & Wickens 1967; Pullan, 1974; Seif El-din 1981; Miehe 1986; Gijsbers *et al 1994;* Boffa 1999). Vandermeer (1997) states that agroforestry science



has failed to systematically investigate the impact of culturally and geographycally distinct traditional agroforestry systems on the *in-situ* conservation of biological diversity. However, farmers in Yemen prefer *Z. spina-christi* for the benefits and services it provides (Table 1), may be, without knowing that other species can provide benefits, such as honey production and nitrogen fixation. The number of tree species can be increased by adoption of on-farm tree planting or conservation of species flowering at different times over the year which may extend the on-farm honey and fodder production season and improve tree biodiversity (Abdel Wahab 2003). The Acacias flowering at different seasons over the year can complement with *Z. spina-christi* in honey and fodder production over a long period as well as they add to the biodiversity of trees in an agroforestry system. Abdel Wahab (2003) concluded that *Z. spinachristi* and the Acacias are the most prefered by honeybees.

On-farm research and awareness raising may positively change the attitude of farmers towards species like *A. tortilis* and other species of the genus *Ziziphus* and enhance biodiversity conservation as an integral part of the farming system. In addition, protection of the natural composition in the upper slopes of Wadi Hadhramout may also lead to bio-diversity conservation. Protection of small woodlots as natural reserves within the agricultural land in the lower zone, on the other hand, may facilitate bio-diversity conservation in that area but will be confronted by land hunger.

Conclusions

Z.spina-christi constitutes an important component in the land use system in which tree growing is integrated with agricultural crops.

Farmers manage the tree for its wide range of benefits including wood and non-wood products such as fodder and honey besides its protective role to the environment. The species can sustainably be managed by selective cutting over long rotations

Adoption of an agroforestry production system may be in favor of the development of the tree species preferred by farmers but may have negative impact on the bio-diversity. On-farm research and awareness raising among farmers can change farmer's attitude to integrate other species in their farming system.

The contribution of *Z. spina-christi,* in economic and environmental aspects, indicates new roles for farmers, scientists and extension staff in farming systems development and management.

Collaboration between farmers, researchers and extensionists will speed up the learning process of the farmers and transfer the knowledge between then through their interaction with scientists.

Adoption of a strategy, by government, based on reservation of natural forests on the upper slopes and within the agricultural areas may lead to conservation of bio-diversity.

Acknowledgement

Thanks are due to the ministry of Agriculture and the General Directorate of Forestry and Desertification Control in Yemen for the financial support and assistance in data collection

References

Abdel Wahab, S.M. 2003. flowering times of the plants of Khartoum State with reference to their importance for honeybees. A thesis submited for the degree of M.Sc. (Agric). Faculty of Forestry, University of Khartoum.

Abdul-Galil, F. M. and El-Jissary, M. A. 1991. Cyclopeptide alkaloids from *Ziziphus*

spina-christi. Phytochemistry, 30(4): 1348-1349.

Al-Akeely, M. A. 1985. *Dictionary of Plants in Jizan Area.* Dar Al-Bilad Press, Jeddah, Saudi Arabia.

Alriksson, B. and Ohlsson A. 1990. Farming systems with special reference to Agroforestry. A minor field study for (FTP). for culture, archaeology and Museums. Seiyun muderia Hadhramout, (Arabic) Working paper. 129pp.

Al-Subban, A.M. 1985. Shibam town in line. Yemen Research center.

Al-yousfi, A.M.D. 1997. The role of forestry extension in the development and management of communal and farm forestry inYemen. M.Sc. Thesis Fac.of For. Univ. of Khartoum.

Bailey, L. H. 1947. *The Standard Cyclopaedia of Horticulture.* Macmillan & Co., New York.

Batheib, A.S. 1991. Medicinal plants in Yemen Extension Bookshop Sana'a (Arabic).

Boffa, J. M. 1999. Agroforestry parklands in Sub-saharan Africa. FAO Conservation Guide no 34. 230pp.

Cherry, M. 1985. The needs of the people. In: Plants for arid lands. E. G. Wickens J. R. Goodin and D. V. Field (eds). Unwin Hyman Ltd. London. pp 1-8.

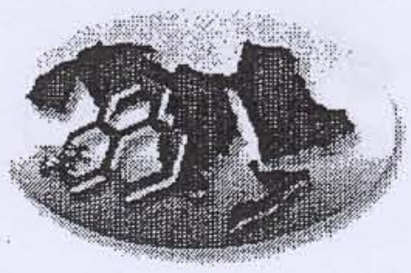
Elamin, H. M. 1990. Trees and Shrubs of the Sudan. Ithaca Press Exeter, 8 Richard Road Exeter EX4 4JA. 484pp

Elsiddig, E. A. 1980. Stem and branch volume of *Acacia nilotica* plantation along the Blue Nile in Sudan. Ph.D. thesis, UCNW, Bangor.

Elsiddig, E.A. and Batahir, A.S. 2003. Uses of *Ziziphus spina-christi* as a component of Agroforestry system in Yemen. U.K.J.of Agric Sci. 11(1).

Gijsbers, H. J. M.; Kessler, J. J. and Knevel, M. K. 1994. Dynamics and natural Regeneration of woody species in farmed parklands in the Sahel region (province of Passove, Burkina Faso). Forest Ecology and Management, 64 (1): 1- 12.

Hubaishi A. and Huhenstein, K.M. 1984. An introduction to the vegetation of Yemen. Ecological basis, floristic composition, human influence. GTZ, Escborn.



Hutchinson, J. and Dalziel, J. M. 1958. *Flora of West Tropical Africa.* Crown Agents, London.

Leakey, R. R. B. 1996. Definition of agroforestry revisited. Agroforestry Today 8 (1): 5-7

MacDickens, K. G. 1991. Selection and management of nitrogen fixing trees. Winrock International, Marriltion, Arkansas, USA.

Maydell, H. J. 1986 Trees and Shrubs of the Sahel. Their Characteristics and Uses GTZ, Eschborn.

Miehe, S. 1986. *Acacia albida* and other multipurpose trees on the Fur farmlands in the Jabal Marra highlands, Western Darfur, Sudan. Agroforestry Systems, 4: 89-119.

NAS (National Academy of Science) 1980. Fire wood crops, shrub and tree species for energy production. Board on science and technology for international development commission on international relations. Washington, D.C.

Ottoman, A.M. Saed, A.A. and V.S. crostina 1989. Forest trees booklet information on some forest trees of Yemen. Ministry of Agriculture and fishery Wealth (Arabic).

Pareek, O. P. 2001. Ber, Fruits for the Future 2. International Centre for Underutilised Crops, University of Southampton, Southampton, SO17 IBJ, UK

Pullan, R. A. 1974. Farmed parklands in Western Africa, Savanna 3: 119-151.

Radwanski, S. and Wickens, D. 1967. The ecology of *Acacia albida* on mantle soils in Zalingei, Jabal Marra, Sudan, Journal of Applied Ecology, 4: 569-579.

Seif El-Din, A. G. 1981. Agroforestry practices in the dry region, In: L. Buck (eds), Kenya National Seminar on agroforestry, 419-434, Nairobi, ICRAF.

Scholte, P. Khuleidi, A.W.and J.J. Kessler 1991. The vegetation of the Republic of Yemen western part. Evironmental protection council. Agricultural Research Authority. Range and livestock improvement project. Dhamar.

Shappira Z., Terkel J., Epozi J., Nyska A. and Friedman J. 1990. Reduction of rodent fertility by plant consumption, with particular reference *to Ziziphus spina-christi. Journal of Chemical Ecology,* 16 (6): 2019 - 2026.

Vandermeer, J. 1997. The agroecosystem: a need for the conservation biologists. *Conservation Biology* 11(3): 591 - 592.

Vashishtha, B.B. 1997. Ziziphus for drylands - a perennial crop solving perennial problems. Agroforestry-Today. 1997, 9: 3, 10-12.

Von Carlowitz, P. G. 1986. Multipurpose tree and shrub seed directory. ICRAF, Nairobi.

Webb, D.B.Wood, P.J. Smith ,J. P. and G.S. Henman, 1984. A guide to species selection for tropical and subtropical plantations, unit of tropical Silviculture. Common wealth Forestry Institute, Univ. Oxf.

YCRCA and ASSU 1984. Results of the joint work of the Yemeni-soviet Association (Arabic). 30p.

Young, A. 1989. Agroforestry for soil conservation. CAB International, Wallingford, UK. 276p.