DEDICATION

To the Great prophet Mohammed
(peace and prayers be Upon him)
To my family, friends for their moral
support and encouragements.
To all farmers (gum gardens owner)
in Sudan.

Gammer-eldien Abdel Rahman

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I thank Allah, The merciful and gracious for giving me the health and power.

ABSTRACT

Effects of Some Ecological and Socio-economic Factors on Sustainable Management of *Acacia senegal* var. *senegal* In North Kordofan State

This study was conducted at ElObied, ElRahad and UmRawaba areas in North Kordofan State. The objectives were to determine the current condition of *Acacia senegal* growing stock and its management for gum production; to investigate the farmers perception, awareness and attitudes towards better conservation and management of the tree. The aim was to formulate a strategy and approaches for improving the management of the tree for sustainable production of gum arabic.

Stratified random sampling techniques were followed to select nine villages (three in each area) on the basis of population size. To determine the stocking, regeneration and growth parameters, 27 sample plots (17.8m is radius of a circle) were randomly selected to represent stocking densities of the tree stands.

A social survey was curried out in the nine villages. The sample size of respondents was proportional to the size of villages. A total of 90 respondents constituting 10% of population were randomly selected to investigate the socio- economic aspects of gum production.

The study showed that the condition of growing stock of the *Acacia senegal* tree in terms of crown and height development, differs according to the density of stands. The management of the tree at UmRawaba area seems to be in favor of stand development and improvement. For example, the overall mean stocking in this area was 295 trees/ha compared to 182 trees /ha and 140 trees /ha at El Obied and ElRahad areas, respectively.

The results also showed that the *Acacia senegal* stands were mature or over-mature with an average crown diameter of 5.0 m and a height of 5.4m. More than 70% of the interviewed farmers expressed great interest in tree planting, protection and management of gum arabic tree for improving their livelihood, enhancing agricultural environment and achieving ecological stability.

The cooperative societies in the area were found to play a vital role in backing up the framer's tree-management interventions. The study revealed that the area under the Hashab tree declined sharply from 50 Mukhamas (36.5ha) to less than 10 Mukhamas (7.3ha) per person at present, and the average amount of gum produced per tree ranges from 500-1000g.

The low density of the tree cover in some of the areas was due to the abandonment of the traditional bush-follow system where only 10% of farmers practice this system. The feasibility of gum arabic price seems to be the driving force of adopting the system or otherwise. Therefore, the study recommends adoption of new approaches for the improvement of the existing farm management systems through a balanced integration of *Acacia senegal* with field crops using sound agroforestry practices in North Kordofan State.

بسم الله الرحمن الرحيم

ملخص الدراسة

أثر بعض العوامل البيئية وإلاقتصادية إلاجتماعية على الإدارة المستدامة لأشجار الهشاب بولاية شمال كردفان

أجريت هذه الدراسة بمناطق ام روابه، الرهد والأبيض بولاية شمال كردفان. هدفت الدراسة لتحديد الوضع الراهن للمحزون الشجرى للهشاب في المشاجر الطبيعية ومعرفة الأنماط المتبعة في إدارتها. كما هدفت الدراسة للتحقق من مستوى الوعي وإنطباعات المزارعين وسلوكهم تجاه المحافظة وإدارة أشجار الهشاب. أما الهدف الرئيسي لهذه الدراسة هو إستنباط إستراتيجيات ومفاهيم للإدارة المستدامة لشجرة الهشاب لإنتاج الصمغ العربي .

تم إستخدام طريقة العينة العشوائية الطبقية لإختيار تسع قرى وذلك بناءاً علي عدد السكان في كل من المناطق الثلاث ولتحديد الكثافة الشجرية (tree stocking) والتجديد الطبيعي وخصائص النمو لأشجار الهشاب، تم إختيار 27 عينه عشوائية دائرية (بنصف قطر 17.8 متر) لتمثل الكثافات الشجرية المختلفة للهشاب.

أجرى مسح إقتصادي وإجتماعي للمزارعين فى التسع قرى، وأخذت عينة عشوائية طبقية بنسبة 10% من جملة عدد سكان الأسر حسب حجم كل قرية ليصبح عدد المستهدفين حوالي 90 مزارع.

أوضحت الدراسة أن الوضع الراهن للمخزون الشجرى للهشاب، علي حسب خصائص النموؤ المتمثلة في إرتفاع الأشجار وقطر التاج، يختلف حسب كثافة المشاجر. وتبعاً لذلك يبدو أن نظام إدارة أشجار الهشاب في منطقة ام روابه يؤدى إلي تحسين وتطوير المجاميع الشجرية .إذ نجد أن متوسط كثافة الأشجار في الهكتار تتفاوت من منطقة لأخرى، حيث تعتبر منطقة أم روابه ذات كثافة شجرية عاليه تمثل 295 شجرة/هكتار مقارنة بكثافة 182 شجرة/هكتار و 140/هكتار في كل من الأبيض والرهد علي التوالي.

أظهرت النتائج كذلك أن أشجار الهشاب في المشاجر الطبيعة ذات أعمار كبيرة حيث أن متوسط قطر التاج حوالي 5.0 m، أما متوسط الارتفاع فيبلغ حوالي 5.4 m.

أكدت الدراسه بان أكثر من 70% من المزارعين المستهدفين لهم الرغبة الشديدة فى زراعة أشجار الهشاب و حمايتها وإدارتها لتحسين مستوى معيشتهم مع تحسين البيئة الزراعية لتحقيق إستقرار النظام البيئي.

وجد أن جمعيات المنتجين في بعض مناطق الدراسة لها دور كبير وفعال في توعية المزارعين وذلك من خلال تشجيعهم وإستيعابهم للمشاركة في إدارة

أشجار الهشاب. كما أظهرت الدراسة بـان هنالـك نقصًـا حـاداً فـي المسـاحات المغطاة بأشجار الهشاب بالنسبة للمزارعيـن، حيـث تقلصـت مسـاحة الغطـاء الشجري من 50 مخمس (36.5 هكتار) إلي أقل من 10 مخمس (7.3 هكتار) في الوقت الراهن وأن متوسط إنتاج الشجرة الواحدة من الصمغ في الموسـم يتراوح ما بين 500 – 1000جرام.

أيضا أظهرت النتائج بأن إنخفاض كثافـة الغطـاء الشـجري للهشـاب فـي بعض مناطق الدراسة، يعزى إلي عدم تطبيق نظام الـ(Bush-Fallow system) وأن حوالي 10% فقط من المزارعين يمارسـون هـذا النظـام. كمـا أن أسـعار الصمغ العربي أحيانا تبدو من المحددات لتبنى هذا النظـام أو تجـاهله مـن قبـل المزارعين.

أوصت الدراسة بضرورة تبني مفاهيم جديدة لتطوير النظم الحالية المتبعة فى إدارة جائن الهشاب وذلك من خلال إستحداث نظام تكاملي متوازن للهشاب والمحاصيل الحقلية (A balanced integration of *Acacia senegal* with field crops) فى ممارسة سليمة لانظمة التكامل الزراعى الغابى بولاية شمال كردفان.

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ABBREVIATIONS

ANOVA	Analysis of Variance
BFS	Bush- Fallow System
DECARP	Desert Encroachment Control and Rehabilitation Program
FAO	Food and Agriculture Organization
FNC	Forests National Corporation
FRC	Forests Research Center
Khor	Gulley, seasonal water courses
Ha	Hectare
Hafir	Water storage reservoir filled by the harvesting rain water in a

	catchments
IES	Institution of Environmental Studies
IIED	International Institution for Environmental and Development
IUCW	International Union for Child Welfare
KAEP	Kordofan Agroforestry Extension Project
NAS	National Academy of Science
NGOs	Non-Governmental Organizations
NKRDP	North Kordofan Rural Development Project
SCF	Save the Children Funds
SAS	Statistical Analysis System
SPSS	Statistical Package for Social System
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNICEF	United Nations International Children's Emergency Fund
UNSO	United Nations Sudano-Sahalian Office
W	Wadi

GLOSSARY

Density: is the number of individual of species per unit area.

Cover: is the proportion of the ground that has a cover of a certain species and would be shaded by it's the individual, or it is the proportion Occupied by species related to the ground surface, but in woody vegetation.

Fallow period: is apiece of land where no crops have been to plant so that the soil has a chance to rest and improve.

Plot: is a part of the area of forest demarked or be inventory

Stand: is an area of growing trees in forest land, elite stand or full stand

Regeneration: the renewal of a forest trees.

Farming system: complex of different human activities to exploit the environment, growing crops, keeping animals etc

Shifting cultivation: System of land use in which short periods of cropping alternate with long fallow periods during which the soil fertility recovers.

Mukhammas: An area which equivalent 7350 square meter