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Evaluation of Some Orchards Management Practice under River Nile State - Sudan

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Abstract **– The study was conducted to investigate socio-economic characteristics of citrus and mango growers, technical gaps and pest and disease problems among 74 randomly selected citrus and mango farmers using closed structured questionnaires in 3 selected localities in the River Nile State. Study deepened mostly in primary data collected through structured questionnaire. The data analyzed using descriptive analysis. The results revealed about 40% of respondent are well educated (secondary level and more) and were in the age class 55.3 with 33 years experience and family sizes of about eight person and two of them work in field, Agricultural sector are dominated by government (66%.) While the production system are dominant by private producers (62%) and only 7% was government. Jerif and island soil was the most fertile soil in the study area but due to the limitation of these land orchard farms expanded in the kurro and higher terraces by 37% and 18% respectively. Source of seedling was mainly from personal nurseries (57.5%) and only 18% and 27% from ARC (Agricultural Research Corporation) and ministry of agriculture nurseries respectively. 81.0% farmer apply urea fertilizer to their fields flowed by organic fertilizer 62.2% little attention was given to phosphorus (1.4%) and potassium (2.7%). In the aspect of orchard care, majority of respondents (78%) are weeding once a year in comparison with about 10% who weeds monthly. Pruning trees is done by majority of farmers (92.2%). Most of respondents (76.7%) are irrigating the fruit trees every 10- 15 days along the year and 67% of them used River Nile as the main source of irrigation. Fruit Orchard under study was mixed between mango and citrus. In aspect of orange the main variety was Sinnary (71.4%) flowed by Nouri 16 (10.2%). while Grape fruits was leaded by foster (52.4%) followed by Red blush (38.1%). Most of respondent grew mixture of mango varieties in their farms (85.3%) but only 8.8% of them grew Abusamaka variety. Average infestation of pest and disease at field work was recorded as 96.9%, 27.7%, 92% and 60% for Fruit flies Leaf minor Gummosis and die back respectively. Not only the study showed a reasonable level of farmers' expertise but also they need scientific intervention in such aspects as fertilizer, weeding, source of seedling, planting of export varieties and pest and disease controls.**

The recommendations were: the ministry of agriculture of RNS (River Nile State) must give more attention to fruit orchard package and put a strong technical heuristic program in collaboration with ARC and The other relevant authorities in aspect of cultural practices management and encouraging interring of new citrus varieties especially orange varieties which were not compete in international market.

Keywords **– River Nile State, Agriculture, Orchards Management.**

I. INTRODUCTION

The Sudan is an agricultural country. Eighty percent of their populations rely on agriculture for living. Agriculture employs 90% of the country's labour force and its industry - and those whom it employs - is mostly dependent on its agricultural products. The country's exports and foreign cash earnings are 90% agricultural (Mahmoud *et. al.*, 1996). Sudan is named as one of three countries, with Australia and Canada, to solve the problem of food insufficiency in the world (*Eltoum 2009*). The diversity of climate in the Sudan provided the country with the opportunity to grow various types of fruit crops, including date palm, banana, guava, citrus fruits and mango. Citrus fruits including oranges, grapefruits and lime are major fruit crops introduced to Sudan over the years. They are distributed almost all over the country. Some old cultivars and new introductions of citrus are grown. Also mango is one of the major fruit crops introduced to Sudan and grown almost all over the country (Mahmoud *et. al.*, 1996).

The Sudan diverse environmental conditions ranging from the desert zone in the north to the humid tropics of the south, beside the many soil types, offer a great potential for growing citrus, which production in Sudan is mainly confined to the alluvial soils of the Northern, River Nile, Blue Nile States and to silt deposits and clays of Khartoum, Blue Nile, White Nile, Gezira, Southern States and Jebel Marra region (Hamid, 1992). Success of mangoes in the Sudan could be attributed to the possibility of extending its fruiting season eleven months a year according to the various environmental conditions. This prolonged fruiting period offers the Sudan with extending possibilities for export in the world market (El Mardi and El Awad, 1983). Mango has a regional and international demand due to its palatable and adored taste with great nutritive value in addition it has a great chance for new markets abroad. On one hand, the basic weaknesses of mango are that it is a highly perishable commodity and lacks in the pre- and post-harvesting technology, as well as in the marketing channels (Eltoum, 2009), on other hand the proposition of a new citrus bud wood registration program that will regulate the citrus culture in the region as well as other parts of the Sudan will benefit the commercial production of citrus substantibility (Ahmed *et. al*., 1984).

Commercial citrus production in many countries plays an important role in national economy. Such role was achieved with the establishment of well organized citrus improvement programs (Child, 1964), this situation

became apparent and of paramount importance in Sudan, when talks of diversification in cropping pattern were common in the early 60's. Citrus research programmes were accordingly established in northern and other region of Sudan. Several citrus cultivars were introduced and compared with the local collection for their production pattern (Dinar and Osman 1983). Indeed, agricultural extension is an essential tool for rural development (Oakley and Garforth, 1985), as it facilitates both the adoption of technology and the adaptation of technology to local conditions (Anderson and Feder, 2003). The adoption of new technologies and new production approaches in farming activities is becoming crucial for countries to meet the challenges of rapidly expanding populations and decreasing availability of agriculturally productive land (Umali and Schwartz, 1994). The new agricultural technologies and knowledge are typically developed and validated by research scientists, and the task of extension agencies is to promote the adoption of these technologies by farmers, thereby increasing agricultural productivity (Belay and Abebaw, 2004). Recently many orchards of mango and citrus in the River Nile were deteriorated and faced numerous problems due to many reasons. The objective of this study is to assess the behavior of River Nile State citrus and mango farmers with respect to agricultural research under the current extension and research system. This survey was attempted to identify the socioeconomic characteristics of the orchard owners in the study area, the main problems/constraints and to get some suggestions from the respondents to set solution in this state. The specific objectives were as follows:

1- To investigate socioeconomic characteristics of citrus and mango growers.

2- To evaluate technical packages of citrus and mango applying by growers.

3- To determine effect of some variables, namely, Farm size, fertilizer and manure application, disease and pests in fruit orchards.

4- To find out citrus and mango growers problems and constrains from their point of view.

II. Materials and Methods

This study aimed to find out technical gaps in cultural practices situation of the orchards grown under different localities of the River Nile State.

Sampling area:

River Nile state which represent with Northern region the North part of the Sudan, is leading fruit production specially mangoes and citrus. It is located between Latitudes 16-22North, and Longitudes 32-35South. From the North, it's bordered by the Arab Republic of Egypt from the East Kassala and Red Sea States and on the South Khartoum State and from West the Northern State. The River Nile traverse the lands of the State on its way Northwards towards its Mouth, where it is joined by Atbarah River. The State's area is 122.1 thousand square Kilometers. It is ranked as sixth State in terms of area among the Northern States, where it is headed by Northern State- Northern Darfur- Red Sea- Northern Kordofan- South Darfur with total population of 1,240,440 persons (Eltoum, 2009).

Sampling size and data collection:

Fieldwork for this study was conducted during season 2006/2007 primary data was obtained through limited interviews using structured questionnaire with open and closed ended questions with key informants from target groups including farmers. The collected information included socioeconomic characteristics of orchard owners, area grown, varieties, crop management, pest and disease problems beside the constraints that hindering the fruit production and suggested solutions.

Data analysis:

Collected data was analysed using descriptive analysis where means, standard deviations, and frequencies were generated to obtain the stated objectives.

III. Result and Discussion:

Sample size and location:

About 74 orchards were surveyed during the formal survey during season 2006 /2007. The respondents were selected from 11 villages that distributed among three administrative units in River Nile State (Table 1).

Table 1: Sites visited for data collection:

Area	Frequency	% of farmers
Shendi	28	37.8
Eldamer	30	40.6
Berber	16	21.6
Total	74	

Source: Field survey, 2007

Socioeconomic characteristics of the surveyed orchard farmers:

Table (2) showed socioeconomic characteristics of the sampled orchard farmers. Average age was about 55 year old with family sizes *of* nine persons per household and about two persons from each family working per an orchard. Also the result showed great experience in orchard management and fruit production among respondents (about 33 year experienced) with about 40% of respondent are well educated (secondary level and more). Agricultural sector are dominated by government, 66%. while the production system are dominant by private producers (62%). Some of respondents are working for others (companies 3%), About 28% of respondents are rented the orchards and only 7% was government.

Great number of family have its advantages in orchard production where members are usually used for supervision of work, providing food for labor, assist in some of field works, working as a labor at orchard etc. On other hands this education status is encouraging and may show that there is great potential for improvement in citrus and mango production in the study area considering that enlightened farmers are normally more open to adoption of new technologies (Williams, 1984).

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Table 2: Socioeconomic characteristics of fruit producers in River Nile State

Item	Mean (std)/ %
Age (years)	55.3 (12.1)
Family size (person)	8.5 (3.4)
Family members participating in agric. work (person)	2.2 (1.4)
Experience years	32.8 (14.9)
Education level:	
Illiterate	9.6
Khalwa	8.2
Basic	27.4
mid	15.1
Secondary	26.0
University	13.7
Agricultural sector:	
Government	66.3
Private	33.8
Production system:	
Government	7.0
Company	2.8
Rent	28.2
Private	62.0

Source: Field survey, 2007

Land type: Table (3) showed the type of land that grown by fruits in the study area. Jerif are the most fertile soil in the study area but due to the limitation of these land orchard farms expanded in the kurro and higher terraces soil by 37% and 20.9% respectively. These lands, kurro and higher terraces, are required use of nutrients i.e. fertilizer. Growing in the higher terrace land indicate the trend of expansion in the agricultural activities and crop production in River Nile State.

Table 3: Farm land type among sampled fruit producers in River Nile State:

Land type	% of respondents
Jerif	14.9
Kurro	37.3
Higher terraces	20.9
Mix	21.0
Other	6.0

Source: Field survey, 2007

Cropping pattern:

The surveyed fruit orchards are mainly grown by mango and citrus in an average area of about 8 feddan. Orange and grapefruit trees are dominating the orchards with about 82% and 70% respectively, followed by mango, 49% of orchards (Table 4). The average area grown by each fruit types is ranged between 4.6 feddan for mango to 0.3 feddan for sour orange (Table 4). Orange are grown in 3 feddan while grape fruit grown in about 2 feddan. Lime and sour orange are grown by less orchards, 23% and 3% in respectively. The age of fruit trees are ranged between one year to 50 years for orange and grapefruit trees, with an average of about 19 years for each, while reach 60 years for mango trees, with an average of about 27 years. Average age of lime and sour orange is about 15 and 13 years respectively. In aspect of mango planting Shendi was higher followed by Barber and Eldamer area with 96%, 38% and 10% of respondent respectively. While Berber was higher in orange fruit followed by Eldamer and Shendi with 100%, 97% while 57% of respondent respectively Table (5).

Table 4: Cropping pattern in the surveyed orchards mean areas, percentage of respondents, range trees age (yrs), and mean trees age (yrs)

Item	% of respondents	Mean (std)	Trees age range (years)	Mean trees age (std)
Total farm area		8.4 (7.7)		
Orange area	82.4	3.0 (5.0)	1-50	18.8 (13.8)
Grapefruit	70.3	1.8 (1.5)	1-50	18.9 (13.5)
Sour orange	2.7	0.3 (0.0)	4.7-30	12.9 (11.7)
Lime	23.0	0.8 (0.6)	2-45	14.6 (11.5)
Mango	48.6	4.6 (7.7)	1-60	27.0 (16.2)

Source: Field survey, 2007

Table 5: Cropping pattern in production areas

Items	Shendi		Eldamar		Berber		Total	
	Mean (fed)	% of respondents	Mean (fed)	% of respondents	Mean (fed)	% of respondents	Mean (fed)	% of respondents
Total farm area	12.8		5.9		5.8		8.4	
Orange area	4.7	57	3.0	97	1.4	100	3.0	82
Grapefruit	2.3	46	2.0	93	0.5	69	1.8	70
Sour orange	0.3	4	0.3	3			0.3	3
Lime	0.7	54	0.3	3	2.0	6	0.8	23
Mango	6.0	96	0.5	10	0.2	38	4.6	49

Source: Field survey, 2007

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Varieties of citruses and Mango grown in the study area:

Citrus: Nouri 16, Sinnary, Baldy, and Egyptian varieties were grown in the study area. Some respondents, 8%, grew mix of these varieties in their orchards (Table 6). Lime is mainly local variety that grown in the area.

In Sudan efforts were made during the seventies to collect and conserve some of the local and old cultivars but also faced with lack funding and proper management, new Cultivars introductions to Sudan:

a. Sweet orange: (1. Naval group: (Gillete- Frost-Parent-Thackery). 2. Valencia group: (Campbell- Olinda). 3. Hamlin

b. Grapefruit (Carpenter- Davis- Duncan- Howell- Little river- L.V.M. Brown- Miami- Marsh seedless- Red blush - Ruby (Mahmoud *e.t al.*, 1996). None of them were found in farmers orchards under the study except Red blush in small amount (38%).

Table 6: % of orchards that grow citrus varieties in the study area

Crop	% of respondents
Orange variety	
Nouri 16	10.2
Sinnary	71.4
Baldy	8.2
Egyptian varieties	2.0
Mix	8.2
Grapefruit variety	
Foster	52.4
Red plush	38.1
Balady	2.4
Mix	7.2

Source: Field survey,

Mango: Abu samaka, Alphonse, Kitchner, Mabrouka, South Africa and Bizra (which mentioned by one respondents) are grown in the study area. Most of them grow mixture of the varieties in their orchard see table (7). Most of farmers know little information about mango cultivars (85% of cultivars are mixed).

About 57 cultivars are reported to exist in Sudan. They are categorized into three groups: True Indian cultivars, Egyptian seedling cultivars of Indian origin such as Zibda, Alphons, Malgoba and Hindibesinara, and Sudanese seedling cultivars of Indian origin of high quality including Shendi, Taimoor, Nailm, Mabroka, Debsha and the famous sort Abu Samaka. (UNEP, 2005, pp 16-17).

Table 7: Grown varieties for citrus among surveyed orchards

Mango variety	% of respondents
Abusamaka	8.8
Kitchner	2.9
South Africa	2.9
Mix	85.3

Source: Field survey, 2007

Source of irrigation: The River Nile is the main source of irrigation, 67% of surveyed orchards. Few, 4% irrigate from underground water while the remains, 29% using both source of water see figure (1).

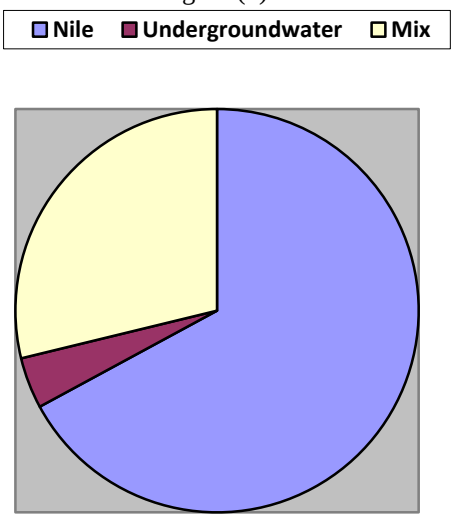

Fig.1. Source of irrigation water among respondents
Source: Field survey, 2007

Crop management:

Irrigation regime: Majority of respondents are irrigating the fruit trees every 10- 15 days along the year. Few, 18%, irrigate weakly during summer and 4% during autumn. While during winter 7% irrigating every 20-30 days.

For good citrus fruit production, trees require irrigation throughout the year. Water requirements vary according to climate and soils; from as little as 45 mm to as much as 270 mm per year (Rice *et al.*, 1987). Developing an irrigation strategy to reduce nutrient leaching has the objective of not applying more irrigation water than the root zone can hold. This objective is very difficult to accomplish even for the most experienced and diligent irrigation managers (Thomas and Kelly, 2008) Successful irrigation management maintains sufficient water and nutrients in the root zone to maximize plant growth and health. Growers who focus on improving water and nutrient uptake efficiency will reduce N and P losses and decrease environmental impacts at the same time.

Table 8: Irrigation interval (days) during three seasons, summer, winter, and autumn.

Items	% of Respondents
Number of irrigation in summer:	
weekly	17.8
every 10 - 15 day	76.7
every 20 - 30 day	4.1
non fixed rate	1.4
Number of irrigation in winter:	
every 10 - 15 day	91.4
every 20 - 30 day	7.1
non fixed rate	1.4

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Number of irrigation in autumn:	
weekly	4.3
every 10 - 15 day	87.1
every 20 - 30 day	8.6

Source: Field survey, 2007

Weeding and fertilization: Majority of respondents (78%) are weeding once a year in comparison with about 10% who weeds monthly. About 11% weed 2-3 times a year.

Almost all farmers use fertilizers, different types as urea and animal manure. Average amount used of urea is about 4.7 sacks/feddan. Potassium, phosphorus and foliar fertilizers are used by few of respondents, 3%, 1%, and 4% in respectively table 9.

Table 9: Number of weeding and % of respondents using different types of fertilizers

Items	% of respondents
No of weeding:	
0	1.6
1	77.8
2-3	11.1
12	9.5
Fertilizer types:	
Urea	81.0
Potassium	2.7
Phosphorus	1.4
Organic fertilizer	62.2
Foliar	4.2

Source: Field survey, 2007

Weeds should be controlled in an area 2 m in diameter around the base of each tree. It can be ccomplished through cultivation or with herbicides (Rice et al., 1987). Ground cover management is the manipulation of vegetation ground cover within the orchard to maximize its benefits while minimizing its drawbacks. There are many benefits to be gained by managing the ground cover in orchard blocks including more rapid tree growth, earlier bearing, greater response to fertilizer, reduced tree stress during periods of dry weather, increased fruit size and yield, reduced potential for mouse injury, erosion and insulating against deep cold (frost) penetration (Atlantic Committee 2013).

On ther hand citrus generally require 12 elements apart from carbon, hydrogen and oxygen. These are N, P, K, Mg, Ca, S (macronutrients), Mn, Cu, Zn, B, Fe and Mo (micronutrients) (Davies and Albrigo, 1994). It is well known that nutrients are essential for the proper metabolic functioning of trees and to ensure desirable commercial fruit production (Obreza *et al.*, 1995). Potassium affects fruit quality may be applied routinely to adult trees. Zinc and ium deficiency is quite common in citrus and may be controlled by foliar sprays often together with copper and manganese. Iron-deficiency is cured with chelated iron. Organic manures are beneficial and strongly recommended where available and economical (Elnema, 2010). On other hand organic fertilization programs for citrus emphasize methods to improve soil fertility and health through the use of organic fertilizers and soil amendments. Soil management includes increasing soil organic matter (humus) content by mowing, grazing, growing green manure and N-fixing cover crops in row middles, and applying manures, composts, and natural fertilizers. Annual nutrient application rates for organically grown young trees and bearing trees should be similar to those recommended for conventionally-grown trees (Thomas and Kelly, 2008).

Pruning of fruit trees: Majority of orchard farmers (92%) pruning their fruit trees once a year where some apply it before flowering while others pruning the trees during winter. Only about 8% of the surveyed orchards do not pruning the fruit trees (Figure 2).

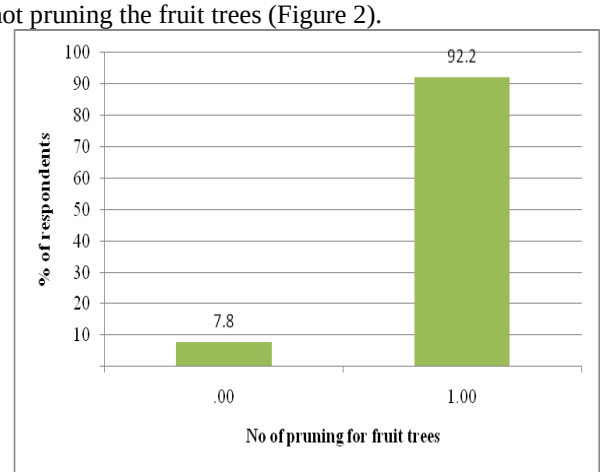

Fig.2. % of respondents that pruning the fruit trees
Source: Field survey, 2007

Pruning should be done for shaping the trees in the nursery before planting in permanent sites and continuously during the early years after planting. It is essential to remove all suckers particularly those from the rootstock. Some scion suckers if left on the tree will acquire a horizontal habit of growth and become fruitful. Inward growing suckers, dead wood, nest of ants and termites and beehives must be removed. Citrus trees have small reserves of carbohydrates unlike temperate fruit trees. Heavy pruning should be avoided since it delays flowering, so very little pruning is done in the tropics. Only old low fruiting citrus trees are usually severely pruned to rejuvenate them (Elnema 2010).

Do you use recommended varieties: Farmers used seedling from personal nurseries (57%) compared with ARC (18%) and Ministry of agriculture (27%). which is not save enough and has its own problem like absence of technical supervision.

Table 10: % of respondents using improved varieties of fruit trees and source of the varieties.

Item	Frequency	Percent
Using recommended varieties	59	93.7
Source:		
Personal nurseries	38	57.5
ARC	12	18.2
Other	4	6.0
Ministry of Agriculture	18	27.3

Source: Field survey, 2007

Pests and diseases: Respondents indicated the appearance of fruit fly and leaf minor in their orchards, 97% and 28% respectively. Few respondents, 17% indicated the appearance of other pests in their orchards. Gummosis was the most infested disease, 92% followed by die back, 60% and powdery mildew, 24% table 11.

Table 11: % of orchards that records pest and diseases

Items	Frequency	% of Respondents
Pests:		
Fruit fly	63	96.9
Leaf minor	18	27.7
Others	11	16.9
Diseases		
Gummosis(tasamog)	58	92.1
Die back	38	60.3
Powdery mildew	15	23.8

Source: Field survey, 2007

Gummosis or root rot is a problem in Sudan soils (Dafalla, 2004), which are poorly drained. Citrus trees are usually grown on mounds to prevent the direct contact of the stem with irrigation water. Prevention is also possible by growing in well-drained areas and by using sour orange as a rootstock. Also recently new method of irrigation for citrus was released with ARC. which irrigation was made using double ring round the trees, and this was the best method to avoid gummosis

IV. Conclusion

In conclusion this survey was done to evaluate the technical gaps in orchards cultural practices adoption by farmers, and from the result of survey we found shortage in technical knowhow in spite of their long experience. Most effort was rely on ministry of agriculture of RNS. More attention must be given to fruit orchard package and a strong technical heuristic program in collaboration with ARC and The other relevant authorities must be establish and encouraging fruit farmers for interring of new citrus varieties especially orange varieties which not compete in international market.

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References

[1] Ahmed E. A., Nourai A. H., Mohamed Ali G. H. and Dinnar H. M. A. (1984). Present horticultural crop production and future prospects in the Northern state. Acta Horticulture. P59-66.

[2] Anderson JR, Feder G (2003). Rural extension services. World Bank Policy Research Working. p. 2976.

[3] Atlantic Committee on Tree Fruits as Publication ACC 1211(2013). Guide to Weed Management in Orchards. Revised Februaryby Perennia

[4] Bally Ian S. E. 2006. Mangifera indica (mango). ver. 3.1Species Profiles for Pacific Island Agroforestry www.traditionaltree.org .

[5] Child, F. G. L., (1964). A report on virus –free citrus bud wood programme for Sudan. Ministry of Agriculture and Natural Resources.

[6] Dafalla, G.A (2004).Virus and virus –like diseases of citrus in Sudan. A paper on present presented in the symposium on citrus production in the sudan present and future prospects. Ministry of Agriculture. Khartoum, Sudan, April, 2004.

[7] Davies, F.S. and Albrigo, I.G. (1994). Citrus production. Concab International Publishers

[8] Rice, R.P.; Rice, L. W.and Tindall, H.D. (1987).Fruit and vegetable production in Africa. Hong kony .pp 40-52.

[9] Dinar H. M. and Osman A. M.A., (1983). Performance of Several citrus cultivars in the arid region of northern Sudan. Acta Horticulture (43). Pp239-243.

[10] El Mardi M. O. and El Awad, D. A., (1983).The performance of mangoes in the Sudan. Acta Horticulture. Pp 221-229.

[11] Elnema A.A. E. and Warrag M. O. (2010). Effect of Position of Cutting and Growth Regulator Application on Vegetative Proliferation of Stem Cuttings of Lime (Citrus Aurantifolia Swingle). (MSc degree). Sudan University of Science and Technology.

[12] Eltoum.S., (2009). Mango in Sudan: Marketing and Export. SLU, Department of Economics.Thesis No 549. Degree Thesis in Business Administration Uppsala, D-level, 30 ECTS credits. ISSN 1401-4084. ISRN SLU-EKON-EX-549—SE.

[13] Hamid, 1992 Hamid, G.A., 1992. Nutritional status of fruit crops in central states of the Sudan and its improvement with special reference to micronutrients. In: Proc. Second Sudanese-Egyptian Workshop on Micronutrients and Plant Nutrition. Dec. 1992, Wad Medani-Sudan, pp. 171–181.

[14] Mahmoud M. A.,Mohamed O. K. Mohamed A. K., Abdel Moneim B. E., Hassan A.R. M. and El Tahir I. M. (1996). Sudan: Country Report to The FAO International Technical Conference on Plant Genetic Resources. Khartoum.

[15] Oakley P, Garforth C (1985). Guide to Extension Training. FAO, Rome.

[16] Obreza, T. A., Alva, A. K., Hanlon, E. A., and Rouse, R. E. (1995). Citrus grove leaf tissue and soil testing: sampling, analysis, and interpretation. University of Florida, Cooperative Extension Service Bulletin, SL, 115, pp: 1–4.

[17] Thomas A. Obreza and Kelly T. Morgan, (2008). Nutrition of Florida Citrus Trees 2nd edition. UF-IFAS SP 169.

[18] Umali DL, Schwartz L (1994). Public and Private Agricultural Extension: Beyond Frontiers. World Bank Discussion. p. 236.

[19] UNEP (United and Action Plan - Sudan (Part II, English version), pp 16-17 Nations Environment Programme), 2005. Convention on Biological Diversity (CBD), Strategy, http://www. cbd.int/countries/?country=sd

[20] Williams, S K T, Fenley, J M and Williams, (1984). A Manual for Agricultural Extension Workers in Nigeria. 169pp.