Economics and Constraints of Palm Date Production and Marketing in Sudan

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ABSTRACT

Date-palms cultivation in Sudan goes back to as early as 4000 B.C. Sudan ranks eighth among the dates-producing countries. The estimated number of date palm trees in the country is about 8 million while annual date fruit production is approximately 320,000 tons, used for both local consumption and exportation. The majority of date palms is grown under the irrigated sector in northern Sudan where the environment is considered as suitable for their production. Palm dates contain vitamins, high calories exceeding 3000/kg and other food ingredients rendering them as highly nutritious foods. With adequate investment, Sudan's date palm plantations have the potential of enhancing development and economic growth. This research was carried out in Sudan's main date-supplying area; namely the Northern Region. Its aim is to assess the situation of dates production and marketing, hindrances faced and how the dates sub-sector could be developed in the country, in particular, and in other producing countries in general.

The study is based mainly on primary data collected using a structured questionnaire. Yet, secondary data is also utilized; having been collected from various relevant sources.

The study unveiled numerous constraints affecting palm date production and marketing. These mainly comprise low crop yield, high cost of production along with inefficient use of agricultural resources, product price volatility, inadequate marketing infrastructure and high cost of marketing. The study concluded that date palm plantations could contribute directly

to agricultural sustainability and alleviation of malnutrition in the region. However, cooperation between stockholders in the sector and intervention of the State are needed to address the constraints in dates production and marketing.

KEY WORDS: date palm, production, marketing, Sudan

INTRODUCTION

The date palm is an important perennial food and cash supplier in numerous African and Asian countries in which its production is successful. Generally, the crop is considered as one of the most important economic perennial crops that thrive in the desert regions of the World. Obeid (1999) mentioned that the date palm is the most important perennial crop in northern Sudan; providing food and income to the majority of the inhabitants there. Palm dates come at the forefront of all crops in the region due to their high nutritional and economic value. Annual income from dates is estimated at around US$ 200 million in the Northern and Nile States, forming not less than 26% and 20% of the total agricultural income in the two states, respectively. Furthermore, the crop has the potential for enhancing rapid development and economic growth if adequately managed.

Sudan boasts of tremendous agricultural resources, including high biodiversity, broad and multiple climates, and numerous water sources that include rivers, rain and a groundwater. Nevertheless, the country is still lagging behind in development when compared with many developing countries. In the country there is a broad range of perennial fruit trees, but probably the most well-known are date palms, banana, guava, citrus fruits and mangoes.

The date palm sub-sector in Sudan is handicapped by many shortcomings that affect crop production and marketable surplus. These include low productivity and high cost of production, which are in turn influenced by prevailing poor varieties as well as lack of improved technology, inadequate agricultural finance, low marketing margins of date products, lack of awareness of farmers of opportunities in international markets, poor infrastructure and inadequate marketing systems, as well as lack of research, extension services, skilled labor and public investments. Generally, date palms in Sudan are still grown

under a conventional system without paying due attention to irrigation water requirements, fertilization or other agricultural practices. However, young date palms are watered initially fortnightly, then monthly for one to three years up to establishment, although irrigation within the River Nile fringes is seldom continued for more than two years. On the other hand, further inland (*swagi land*), several irrigations per year are provided for the first ten years, and on the upper terraces, monthly irrigation may be required throughout the life of the trees.

This study was carried out in the River Nile State of Northern Sudan. The available cultivated areas of the state extend along a narrow fringe of land beside the River Nile occupying about 124,000 km^2 (29.5 million feddans[1]), out of which about 3,201,300 feddans are suitable for agricultural production. A high population density exists in the settled areas along the River Nile and Atbara River with a total population of about 720,000 forming 90% of the State's population (Ahmed, 2009).

Date palm production in north Sudan depends mainly on surface irrigation from Nile. The climate there is extremely dry with very hot temperatures in summer that falls between April and September and relatively cool weather in winter that extends from October to March. The region is blessed with alluvial fertile soils, while the environment is rather favorable for producing relatively high-value crops compared to other regions of the country. Further, this paper looks into options to increase production and yields of date fruits through improving the management of dates farming systems and to maximize producers' returns in the northern region of Sudan.

MATERIALS AND METHODS

Area of the study: The research was conducted on date palm production and marketing in Elketiab public irrigated scheme in the River Nile State. The scheme is considered as one of the main suppliers of fruit products in the district where dates and citruses are commonly produced under surface irrigation from pumps on the River Nile.

[1] One feddan=0.42 ha

Sources of data: Both primary and secondary data were applied in the study. The primary data was collected through a field survey by using questionnaires to interview date-palms growers. Secondary data was collected from relevant sources such as records of the State Ministry of Agriculture, previous studies and the internet; among others.

Sampling: Probability proportional method was used. The dates producing zone in Sudan were stratified into the two geo-administrative zones of Northern Sudan comprising the Northern and River Nile States, and central Sudan represented by Khartoum State.

Data collection: Field questionnaires were administered for 50 date-palms growers in Elketiab public irrigated scheme. In addition to the use of questionnaires, field observations, farmer consultations and farm visits were also made. Data collected was mainly on production, production costs, product marketing and returns, as well as on constraints facing palm dates growers and traders.

Data analysis: A set of analytical techniques were employed including descriptive statistics and linear programming (LP) using GAMS (General Algebraic Modeling System . LP is a mathematical programming technique useful for detecting the best allocation of the farm scarce resources. The model seeks the maximization of gross margins as the underlying objective function:

$$Max Z = \sum_{j=1}^{n} C_j X_j \qquad (1)$$

Such that:

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i, \quad i = 1, 2, \ldots, m \qquad (2)$$

And:

$$Xj \geq 0, allj1ton \quad (3)$$

Where:

Z = objective function value.

Xj = Level of the jth farm activity, such as the acreage of date palms grown. Let n

denote the number of possible activities; then j=1 to n.

Cj = Objective value, in this case the forecasted gross margin of a unit of the jth activity (SDG per feddan).

Aij = quantity of the ith resource (e.g., days of labour or other

quantities of inputs) required to produce one unit of the jth activity

M = Denotes the number of resources; then i= 1 to m

Bi = Amount of the ith resource available (e.g. cubic meters of water, feddans of land, days of labour or other available quantities of inputs).

The objective is to find the cropping system (defined as a set of activities levels X_j, j= 1 to n) that has the highest possible total gross margin, Z, but doesn't violate any of the fixed resource constraints or involve any negative activity levels.

Equation (1) is the objective function, which maximizes the gross margins from one feddan of dates crop.

Equation (2) shows the limits on the levels of the available resources that tenant can apply to produce the crop in question.

Equation (3) which is a non-negativity condition, states that all resources used in the production process and output must be equal to or greater than zero, meaning that negative use of resources and negative production is not allowed.

The basic data used to calculate gross returns per feddan are output value (crop prices times' quantity of output, i.e. yield per feddan), while gross margin per feddan is obtained by subtracting the average total variable cost from the total gross returns. Gross margins reveals how much a firm (farm, company etc.) earns, taking into consideration the costs that it incurs for producing its products and/or services and it could be expressed as a percentage.

Gross margin is a good indicator of how profitable a farm is at the most fundamental level. Farms with higher gross margins will have more money left over to spend on other activities such as investment, improvement of production and marketing. The general mathematical form for the gross margin calculation per crop is as follow:

GM = GR - TVC

Where:

GM = Crop gross margin per feddan in SDG,

GR: Crop gross revenue per feddan in SDG.

TVC: Crop total variable costs per feddan in SDG.

RESULTS AND DISCUSSIONS

The farming system in which date palms are grown in Sudan is stretching slowly with low returns causing many date growers to complain. As far as dates industries are concerned it is known that most varieties are of the dry type; hardly suited for exportation and international competition. They are predominantly consumed as dry fruits in various parts of the country but some is used to make a native alcoholic drink. As by-products, stems are used in buildings and fronds are widely used for household utensils (i.e. thatching, buildings, braiding and

basketry).The survey has shown that a numb of socioeconomic constraints affect the date palm farming system in Sudan. Productivity is low and farmland availability is in shortage. Varietal improvement is constrained by shortage in tissue cultured date palms while appropriate preservation technology is lacking. Dates fetch poor prices and their sale market prospects are rather narrow, being further influenced by high transportation cost, shortage and high cost of labour. Needed inputs such as improved seedlings and agro-chemicals are scarce. The crop is attacked by various insects and diseases, e.g., palms green scale insect, *Asterolecanium phoenicis* (Rao), the termite *Odontotermis classicus* (sjostedt), the white scale *Parlatoria blanchardii*, Targ, and a number of store pests. Further, production suffers from costly provision of irrigation water and lack of financial capital.

Analysis of the main demographic characteristics of the surveyed date-palms tenant growers revealed that their average age was about 50 years, while the family size averaged ten. Those tenants reflected high cumulative farming experience averaging 32 years. The farm size in the targeted scheme varied from 1 to 27 feddans per farm household, with the majority of tenancies (64%) being run on rent basis. In Elketiab farming system date palms accounted for 13%, while citruses occupied 53% of the total farm land. The level of education of tenants, at a particular point, can affect the adoption of modern technologies and improvement of the date palms farm system. The research found that all the surveyed farmers were educated and all of them were males. As high as 76% of them were fully occupied with their farms and about 82% had the engagement of an average of two members of their families in farm production.

Particulars of perennials' production in area of the study

As drawn from the analysis, the perennials farmland allocation, productivity and production are depicted in Table (1), which also compares tenants' yields with those of research. The prevalent perennials crop mix in the scheme mainly comprised date palms, citruses, mangoes, guava and alfalfa. Land under perennials was up to 53% occupied by citruses and 15% by alfalfa, while the shares of date palms and guava were 13% and 11%, respectively. The lowest percentage (8%) was devoted to mangoes.

Research records show that dates' yield attained by Elketiab tenants was generally low when compared with research yields attained from research conducted by Sudan's Agricultural Research Corporation (ARC), with a yield gap reaching 53% as revealed in Table 1. A similar situation applies to other perennials.

Table 1: Distribution of surveyed tenancies and production of perennials

Crop	Average Area (fed)	Percent Area Share	Yield (kg/fed)	Production (kg)	ARC yield (kg/fed)	Yield Gap %
Dates	1.23	12.3	3000	3690	6500	53
Citruses	5.01	50.1	7572.43	17535	-	-
Mango	1.0	10	1625	1625	5000	68
Guava	1.0	10	1050	1050	-	-
Alfalfa	1.76	17.6	6206	10922	8500	26

Source: field survey 2006, AOAD 1998 and ARC 2007

Table (1) indicates high potential to improve dates' crop productivity as well as that of other perennials in the scheme as reflected by the notably higher research yields a compared to farmers'. Differences in crop productivity not only indicate differences in crop production technology, but also differences in crop varieties.

Potential of date palms' production in Sudan

Sudan possesses very high potential for the production as well as suitability for growing different varieties of date palms, including dry and soft ones. This is attributed to the huge and diversified agricultural resources and environment offering favorable conditions and comparative advantage for palm date production. According to Obeid (1999), out of the total

amounts of dates produced in the Northern region about 75% are dry dates, namely those locally named *Barakawi, Gondaila, Bit Tamoud, Kulma, Abdelrahim, Tunisi, Jaw*, while the other 25% includes soft or semi-dry ones (*Mishrig/Wad Laggai* in the Nile State; *Mishrig/Wad Khateeb, Medina, Digla Nour, Jaw in both* River Nile and Khartoum States, and *Gorair* in the Northern State).

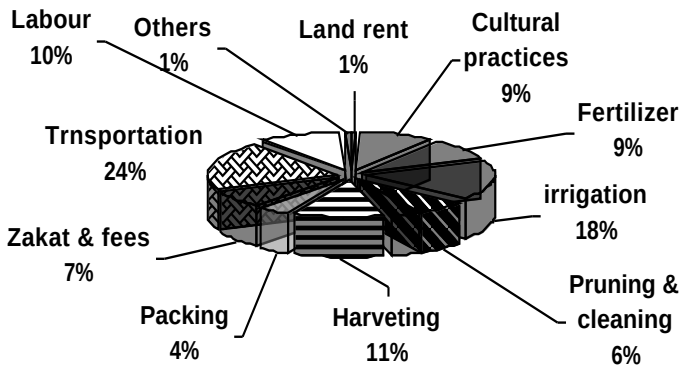
The potential of date palm expansion in Sudan has been identified many years ago by many researchers such as Khairi et al. (2011) and Obeid (1999) as depending on irrigation water supply, land reclamation and varietal improvement. Besides suitable climate and fertile land along rivers banks and basins in the mentioned regions, skilled tenants and abundant irrigation water from the River Nile as well as underground water reinforce such potential. Obeid (1999) reported that the date palm, *Phoenix dactylifera* L., is cultivated in the Northern State along the banks of the River Nile over a distance of about 700 km. The total number of trees is in the order of five to seven million. The total irrigated land in the State under study amounts to 1.2 million feddans, representing about 30% of the agricultural land. Out of the total invested land, 114,000 feddans are occupied by perennial crops (74,000 fed of fruit trees and 40,000 fed of alfalfa). The number of date palm trees amount to about 82,000 trees (MAS, 2009). Generally, these statistics point to great existing opportunities to invest in more agricultural areas, with high chance for going for organic farming systems. At the second half of the last century, the date palms area has been extended in marginal lands in the north region under what is known as "*matrat*" (surface wells) irrigation, indicating the scope for potentially new dates areas. The north region of Sudan is characterized by having limited levels of rainfall, justifying the fact that the dates farming system relies mainly on surface pump irrigation from rivers as well as from underground water.

Dates production costs

Application of an already identified dates' technological package can cut down production costs. Ahmed (2009) reported that resources use efficiency in agricultural production illustrated savings of resources and input expenses. The major components of agricultural production costs in the study area are the costs of material inputs, labor, services, and

management. Previous studies revealed that the high cost of production overall the country has led to low farm profits. The high cost of production is attributed to high cost of numerous production inputs. Therefore, most of the tenants seek various sources of finance to achieve their seasonal plans. Figure (1) reflects that about 11 cost components form the cost of production for palm date crop in area of the study.

Fig. (1) Operation cost components for dates



Source: The field survey 2006

Production economics play a unique role in farm management (Doll and Orazem, 1984). Figure (1) shows that the transportation cost component is considered as the most agricultural hindrance facing palm date crop production and marketing, accounted about 24% of total production cost. This is followed by irrigation (18%) and the components of harvesting, labor, cultural practices and fertilizers, ranging between 9% and 11%. The situation might call for the need for adequate public investments in order to encourage the promotion of palm dates production and marketing..

Marketing of palm dates in Sudan

Date production; processing and trade witness growing challenges to meet consumer expectations as well as quality standards. In Sudan, the marketing of palm dates is one of the important factors constraining dates production. Elfeil (1993) mentioned that the marketing

of crops in the northern region is characterized by being deprived of government involvement; hence dates marketing is the responsibility of the its growers who undertake it individually. The product is usually sold immediately after harvest at unfavorably low farm gate prices. The causes that enforce farmers to sell immediately after harvest are the need for cash along with the small farm products that are too small to be transported to urban markets. The main characteristics of the markets in area of the study are that the prices are usually less than in big city markets. However, local markets are periodical, which provide opportunities for the exchange of different goods among actors who came from different neighboring districts.

Trade in palm date products is still limited by the limitations in domestic markets, whereby Sudan can increase its dates products for export to international markets to enhance market returns and farm incomes, food security and rural development. Trade in dates' products is nevertheless increasing rapidly and it can attain high revenue of hard currency in a short time. Most of Sudanese commodities are well treated before and after harvest and could be sold as high quality products provided the necessary public investment. The world palm dates market is growing at high momentum from one year to another. Palm dates grown for food in Sudan will have a wide-open door in the international market reaching much higher prices and consequently contributing more to the Gross Domestic Product (GDP). The expected higher income for palm dates growers will also be positively reflected on their standard of living. More national revenue means more money available for solving pertaining problems that hinder rural development. Marketing large amounts of palm dates will make the country a prominent figure in the international market of dates' products. It will also attract global investors to invest in agricultural production of the crop (Babiker, 2003). In the last decade, Sudan witnessed improvements in crop marketing due to some progress in its infrastructure that has contributed to facilitating fruit and cereal crops marketing. Although, there are numerous linkages and options for marketing of dates, but still the crop growers face some difficulties to undertake the right decision of where and when to sell their product. The hesitancy of Sudan farmers might be attributed to the high cost and difficulties of transportation and its high cost, in addition to different fees and

charges levied along the roads from rural areas to the entrances of big city markets. Furthermore, the still poor marketing infrastructure is considered as a chronic hindrance facing date producers in area of the study to diversify their markets.

The analysis illustrated that more than 50% of the scheme tenants prefer to sell their crops in near markets, while 46% of them take their crops to big city markets such as Khartoum market about 250-500 km away. The study also revealed that most of tradable palm date crop (56%) was traded in mixed markets around the area of the study, followed by 20% transacted in town markets 12% offered at the farm gate and 8% was brought to village markets. The share of village traders who usually play the role of money lenders to the tenants was found to be 4%.

The study observes that development in communication means has become an essential means for marketable surpluses where they can reduce marketing cost as well as raising farmers' awareness about urban markets. The date palm growers in the area of the study reported that they depend on mixed sources of market information such as local markets, traders, and agricultural officers of the scheme.

Contribution of palm dates to farm sustainability

In spite of the fact that dates producers in Sudan exert great efforts during the growing season – hoping for successful harvests - they face low-price shocks. Accordingly, and given the inadequate marketing infrastructures, they are usually compelled to sell major quantities of their crops immediately after harvest at unfavorable prices, and allocate the remaining portion to future sales as shown in Table 2.

Table 2: Distribution of the disposal of palm dates quantities in the study area

Crop	Total Production	After harvest sale (kg)	Household consumption (kg)	Future sale (kg)

Palm date	3691	2030	554	1107
Percent	100	55	15	30

Source: The field survey

The field survey results denoted that the allocation of marketable surplus to sales at different times, after devoting a portion to household consumption, depends on crop prices. As illustrated in Table 2, farmers store dates in their house yard or in traditional stores for many months waiting for prices to rise. The respondents reported that 45% (1661+ 554) of their date's production go for storage for future sales and household consumption.

Analysis of palm date returns

The second half of the last century witnessed the increase of global demand for organic foods with increasing awareness of their value and benefits. Gross margins for dates under study were assessed in Table 3.

Gross margins of palm dates were positive reaching SDG4776. Although modest, such returns might compensate for date palms investment. Furthermore, with yield improvement of palm date crop, still higher gross margins can be obtained.

Table 3: Gross margin analysis for palm date crop (SDG*)

Item	**Palm date**
Average yield (kg/fed)	3000
Average price (SDG/kg)	48

Gross returns (SDG/fed)	**144000**
Total variable costs (SDG/fed)	**139224**
Gross marginal Revenue**(SDG/fed)**	**4776**

Source: The field survey 2006

In general, farm income in northern Sudan is low. Producers' awareness and market promotion are needed about marketing issues within the promise offered by the existing date palms farming. Although the gross margin of date production was rather low, it is still promising as an important cash and food crop.

Optimal palm date production obtained by the model

Availability of agricultural land and irrigation water form vital precondition for successful investments in different cash, food products and their commercialization. The long history of date palms cultivation in the country has provided a strong background for Sudanese date growers to engage in producing various perennial crops, in addition to field crops and livestock herding; offering promising options for promoting the farming system and improving livelihood of rural people. Yet, the high competition for irrigation water and arable land increases the complexity of agricultural resource management. No doubt that the available resources in north and central Sudan acquire high importance for agricultural production, due to favorable location and productivity potential, but more importantly due high population pressure on land when compared to the rest of the country and specifically the high cost of irrigation water in northern Sudan. The high cost of production coupled with low productivity and lack of a cheap source of power has made it difficult for farmers to realize the full potential of the region (Elsir *et al.*, 2004). In fact, the potential of agricultural resources there for raising both food security and living standards of the rural poor has long been recognized. Generally, in Sudan the favorable crop productivities along the agricultural sector come from the irrigated land. Then the important question here is how to balance the

use of available resources in Sudan? Thus resource-use optimization might be an appropriate means to address this question within the the existing constraints.

The model run in this study provides information on the objective function value optimal crop combination and utilized resources accompanied by their respective marginal value productivities. Table (4) presents the actual and optimal cultivated land for the dominant perennial crop combination and gives also their optimal area allocations for a representative 10-feddans farm of permanent crops.. The tenant's practices with respect to crop area allocation reflect show a dominant trend towards a diverse crop combination in attempt to maximize resources use. This trend has been most likely followed based on long-term experience of farmers to reduce agricultural risks.

The optimal solution, on the other hand, manifests that the allocation of the available land should comprise three crops, namely citruses, mango and alfalfa at 4, 2, and 4 feddans, respectively. The rest of the perennials didn't appear in the optimal plan, indicating their low returns. The actual total gross margins from farmer's crops mix amounted to SDG134998, while the returns from the optimal crop combination would reach SDG 427050. This means 68% more returns, indicating high feasibility of a shift in the cropping pattern. The disappearance of date palms in the optimal solution raises concerns about the need for efforts, including appropriate policies, to improve their productivity, as justified by research results, and set their market prices right. This is justified by the fore-mentioned advantages of date palms in people's livelihood and the actual expansion in their areas. On the other hand, the simplified model – due to lack of information – did not captured issues that would have raised date palm gross margins such as their by-products and the expected notable value of crops that are actually be grown underneath the trees. Furthermore, palm dates are associated with low risks of perishability, long storage potential and low transport costs compared with other fruit plantations.

Resource use and constraints

Table (4) illustrates the optimal and actual amounts of capital use for the different perennial crops under the study, amounting to SDG 1675200 in each. Obviously, in the optimal plan,

all land has been utilized (Table 4), while the optimal and actual irrigation water quantities used were 122976 m^3 and 131256 m^3, respectively, reflecting the use of 94% of total available irrigation water with the optimal plan. The optimal level of hired labor (man-days) amounted to 84, forming 79% of the total available labor. At the optimal crop combination, the monthly distribution of actual available cash to finance the perennial crops was SDG13960 allocated annually over the months, forming to 100% of the total available capital.

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Table 4: Scenario: Proposed cropping pattern plan for palm date in Sudan

Item	Actual	Optimal	Units
Resource use:			
Total land	10	10	Fed
Total irrigation water	131256	122976	Cubic meter (m^3)
Total labor	106	84	Man-day
Total capital	1675200	1675200	SDG
Gross Margins: objective value (Z)	134998	427050	SDG
Cropping pattern:			
Dates	1.23	-	Fed
Citruses	5.01	4	Fed
Mango	1.0	2	Fed
Guava	1.0	-	Fed

Alfalfa	1.76	4	Fed

Source: Model results, compiled data 2006 and 2010

The monthly distribution of actual available cash to finance the perennial crops was SDG13960 allocated annually over the months, forming to 100% of the total available capital. The unused water and labor resources could be utilized in other rewarding activities that do not require land, such as livestock rising, but there would be need for raising capital.

COCLUSION AND POLICY IMPLICATION

The research investigates that Sudan boasts of high potential to promote the production of palm dates due to numerous comparative advantages, namely availability of stable and high quality agricultural resources, suitable environmental conditions, huge experiences of date palms farmers, and the strategic location of the target area for date's production. Strict economic optimality under the prevailing yields and prices is not in favor of date's production but the potential looks promising. Thus government interventions and application of suitable policies are critical to provide incentives to the palm dates producers in the country by giving momentum to technology transfer to attain potential productivity and formulating relevant policies that provide reasonable prices to producers.

It is also evident that proper management of palm dates farms production, handling, processing and marketing is fundamental for sustainable palm date farms in Sudan. This should also be supported by encouraging professional investors and actors in date products marketing to ease the State's responsibility and promote date farms in the country. Nevertheless, public investment is needed to ease palm date production and marketing. Vitally important is the maximization of use of the available agricultural resources for improving date crop combined with the other perennials. Equally important is the need for reviving the marketing system in area of the study and make strong links with national and

international markets. Lastly, the low quality of many of the grown date varieties will need to be addressed by gradually shifting to high-quality dates and accordingly provide incentives to make this crop more profitable due to its importance for food security and farmers' livelihood.

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