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Potentiality of Organic Perennial Crops Farms in the River Nile State of Sudan

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ABSTRACT: It is imperative to note that organic agriculture does not mean turning back the clock to a primitive mode of farming, but it does build on traditional knowledge and practices. It offers a modern, ecologically intensive farming system that can perform successfully without any synthetic fertilizers or pesticides to meet food security and poverty alleviation needs. In Sudan organic farming was carried out by the Arab Authority for Agricultural Development (2001) to produce food commodities free of agricultural pollutants, mainly for export. The certified organic lands area in Sudan is estimated at 200,000 hectare and 650 farms, accommodating different crops such as tropical fruits, groundnuts, but also cotton, herbs/spices, etc. (Lim, 2007). Since organic farming is feasible in the agricultural sub-sector, the aims should be its dissemination in the country and maximization of organic production. This paper considers the River Nile State (RNS) of Sudan as a case study. The RNS is considered as one of the main supplier of perennial–crop products in the country. The production of these crops in the State are faced by numerous shortcomings, namely low level of productivity, high cost of production and inefficiency in resources use. In RNS perennial crops are regarded as essential food and cash crops within the prevailing cropping systems. They also play an important role in the sustainability of the farming systems through natural resources conservation and its good returns to investment with expanded cultivable area. This paper aims to investigate the potentiality and feasibility of organic perennial crops in RNS. Beside secondary data, primary data was collected using structured questionnaires for 50 randomly selected respondents in the study area. Partial budgets were constructed to assess and compare the profitability of organic and conventional perennial crops. The results revealed that tenants would get numerous benefits from organic perennial crops compared with conventional production. The RNS tenants should therefore be encouraged to establish organic perennial farms instead of continuing their traditional way of investments and to be guided on how to grow organic products that give production and yield advantages, earn high returns and contribute significantly to farm sustainability and malnutrition alleviation in RNS.

KEY WORDS*: organic perennial farm*

INTRODUCTION

Perennial crops are important sources of household food security and nutrition in both the humid and semi-arid tropics, besides being regarded as essential cash crops. They can yield as much food per feddan as most annual crops. They also offer great ecological and social benefits, and they can thus be productive and/or protective. Stan (2008) stated that perennial plants are highly efficient and responsive micromanagers of soil, nutrients, and water. Annual crops are not; they

require churning of the soil, precisely timed inputs and management, and favorable weather at just the right time. With shorter growing seasons and ephemeral, often small root systems, annual crops provide less protection against soil erosion, wasting water and nutrients, storing less carbon below ground, and are less tolerant to pests than are perennial plant communities. The situation of organic agriculture is summarized by Taher (2003) that traditional production system in Sudan is close to compliance with EC-regulations 2092/91. They can be qualified as non-certified organic products as their use of chemicals is not common because of high cost or unavailability. There are three projects under certification: one is in Gadareef, the second in Sennar state and the third is in North Kordofan. The project in North Kordofan is based on large groups of small holders working privately and supervised by Organic Products Company (joint venture Company between CEDAR Co. and OTTER Co. - Dutch trading company) which started its activity at the beginning of 2001. The Organic Products Company is the largest exporter of organic products from Sudan. There are other companies that export organic products from wild sources. Markets are mostly European countries. Certification bodies working in Sudan are: ECOCERT, COAE, and ECOA.

Sudan has got a tremendous opportunity to take the lead in the production of organic food in both plant and livestock products. Unfortunately, the country is still lagging behind even in comparison with the African countries. There are several types of fruit trees grown in Sudan. Some of them are ancient in the country while others were introduced not long ago. The most well known fruit trees in Sudan include palm dates, banana, guava, citrus fruits and mangoes. By nature, perennials aren't as inflicting erosion - a growing problem in the country – as annual crops. Moreover, perennials simply grow by themselves after harvest, thus avoiding the relatively expensive sowing operation. They are grown in different regions of the Sudan and the River Nile State is considered as one of main grower of perennial crops. The cultivated areas consist of a narrow fringe of land along the Nile covering about 124,000 km^2 (29.5 million feddans) out of which about 3,201,300 fed 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'e population (Ahmed, 2009). Thus, most of the agricultural production depends on irrigation in areas close to the rivers. The climate is extremely dry with very hot temperatures from April to September and relatively cool from October to March. Along with the alluvial fertile soils, the conditions furnish a comparative advantages situation over other parts of the country in producing relatively high-value crops such as palm dates, citruses, mangoes, guava and alfalfa. While these are regarded as the most important perennial crops, wheat, legumes (faba beans, chickpeas, field beans, and lentils), vegetables, spices, sorghum and maize are the main annual crops in the State. Although the last decade witnessed development in RNS, the State still suffers from some chronic constraints affecting farm productivity and incomes such as high cost of production, inadequate finance, high marketing margins on agricultural produce and inadequate investments in infrastructures and other facilities. This has resulted in annual variations in areas of both perennial and field crops. Peren-

nial crops are considered as strategic crops in the State occupying an estimated total area 120,000 feddans where they distributed over schemes of the State. The State is characterized by the prevalence of three types of schemes: private, cooperative and public schemes with different production relation systems. The public pump irrigated schemes are the important ones for growing perennial crops due to their high acreage share and high number of tenants. The delivery of the irrigation water for the scheme depends on pump irrigation system from the River Nile (RN), and the effectiveness of irrigation is determined by the availability and supply of fuel for water pumping and the degree of siltation in canals in public schemes. Elketiab public irrigated scheme, taken here as a case study, was established in 1917. The management of the scheme, as with the case of other public irrigation schemes of the Northern Region, was under the Northern Agricultural Production Corporation (NAPC). The total area of the scheme is about 12000 feddans, out of which 6200 feddan was cultivated in season 2005/2006. The area is distributed among 389 farms (*hawasha*) where perennial crops occupied about 71% of the total cultivated area, and the remaining portion was under the annual crops. The total number of tenants in the scheme is about 1687. At its start, Elketiab scheme adopted the crop sharing arrangement, which was later replaced by a water-rate system.

The earlier-mentioned problems concerning perennial crops production in RNS are analyzed to see the effect of such constraints as high cost of production, inadequate credit, weak infrastructure and remoteness of the production region on the inadequate interaction with the rest of the country. The study examines how organic farming system can contribute to the improvement of the performance of perennial crops. It is hypothesized that organic-perennials farms system in the State will benefits the tenants and improves farm sustainability.

Problem Statements

The competition for irrigation water and land increases resource management complexity. These inputs constitute the most important factors of agriculture in the River Nile State, due to their scarcity and importance raised from population pressure on land when compared to the rest of the country and from the high cost of irrigation by pumps. They became common problems are aggravated even more by the diminution of the canals capacities and lead to low productivity of crops. Elsir *et al.* (2004) summarized that 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 State. Further, development is considered serious affected by the limitation of these two basic resources of land and water. Yet, the potential of resources for raising both food production and living standards of the rural poor has since long been recognized. Generally, a third of the current crop production comes from one-sixth of the irrigated arable land. This necessitates improved reliability of crop production under greater intensity of land-use with removal of seasonal water supply constraints. Then the problem is how to balance demand and supply of resources under these conditions. The solution lies in resources use optimization. The farmer's trend in RNS towards diverse crop combination is a dominant practice as means of increasing efficiency of resources. This behavior might be acquired by experience to avoid agricultural risks such as pests and unfavorable climatic conditions

(i.e. high temperature, low moisture and others).

The last three decades witnessed critical problems regarding the production of perennial crops. Constraints contributing to the low level and instability of perennial crop yields include poor application of technical packages, stress inflicted by the changing environmental conditions, especially temperature, beside widespread of different diseases, insects, pests, weeds and inadequate irrigation water. Ahmed (2004) stated that irrigation water significantly affects crop production in the State where the irrigated schemes suffer from irrigation shortage due to inadequate supply of irrigation inputs at the proper time and at the right prices. Finally, this study looks into option (s) to increase the productivity of perennial crops through increasing the efficiency of resources-use intensity in RNS's public irrigated schemes. More specifically, the research addresses the issue of organic perennial crops farms to enhance more incomes attainable by producers and to improve the agricultural environment. Success will depend on designing and establishing farmer-friendly environmental system of management that utilizes the limited resources appropriately in the public schemes in the State. Investment in organic perennials farms of the State, at least in its public irrigated schemes, might be instrumental in saving the environment and improving household standard of living.

Methodology

The study was carried out in Elketiab public irrigated scheme of RNS where perennial crops are commonly produced under pump irrigation mainly from the River Nile. The sample size was 50 tenants, selected randomly, forming about 3% of the total tenants in the scheme. The sample size was determined according to the desired level of precision and availability of resources in terms of cost, time and other relevant facilities. Stratified random sampling proportional to size was used. Integrated analytical techniques comprising descriptive statistics, partial budgeting and linear programming (LP) are used to illustrate the potentiality and feasibility of organic perennial crops in area of the study.

Results and Discussion

Starting with main socioeconomic indicators in the study area, the average age of the surveyed tenants is 50 years, while the average family size 10. The tenants are characterized by high cumulative farming experience averaging 32 years. The average farm size in the scheme varies from 1 to 27 feddans per farm household, with most of the farms (64%) on rent basis. The farming system of Elketiab scheme is dominated by citruses production which accounts for 53% of the farm land. The level of education, at a certain point, can influence the adoption of modern technologies and improve the farm system. The study found that all the surveyed tenants are educated and all of them were male. As high as 76% of the tenants were fully occupied with their tenancies and about 82% of their families' members were contributed to farm production with an average of two persons.

Prevalent perennial crop combination

Perennial crops occupy about 16% of the total cultivated area of the scheme in season 2005/06. The dominant perennial crops in the scheme are citruses, date palms, mangoes, guava and alfalfa. The survey revealed that the land devoted to perennial crops was up to 53% occupied by citruses, followed by 15% for alfalfa, while date palms and guava were formed 13% and 11%, respectively. The lowest percentage (1%) was devoted to mangoes as depicted in Figure 1.

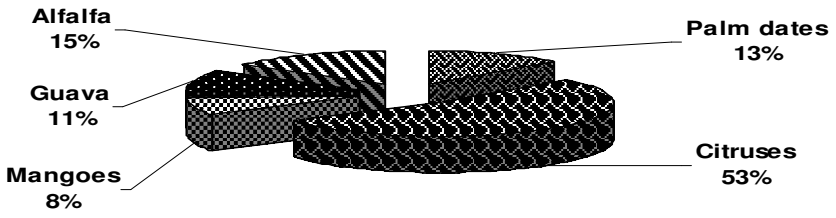

Figure 1: Prevailing perennial crop combination in area of the study

Source: The field survey 2006

Potentiality of organic perennials farms in RNS

Organic agriculture is a production management system, which promotes and enhances ecosystem health, including biological cycles and soil biological activity. It encompasses a range of land, crop and animal management procedures that use little or no external inputs. Organic agriculture promotes the use of local natural resources (Byiringiro, 2003). The potential for expanding organic agriculture in Sudan is great. Large areas are cultivated without chemical and can be easily converted into certified organic areas (Taher, 2003). Babiker (2003) also reported that Sudan possesses a very high potential for the production of Organic foods. This is attributed to the huge natural resources and the wide range of biodiversity available with high relative advantages, which justify its lead in organic food production. The National Institute of Environmental Studies is entrusted with carrying out all the necessary studies including field surveys, data collection and selection of more suitable regions for organic farming in the country. Three states were chosen for this purpose, namely Northern Kordofan, Sinnar and the Nile River States.

The possibility of agricultural expansion in the River Nile State has been identified by the Arab Organization for Agriculture Development (AOAD) before two decades as depending on water supply and land reclamation for crop production. The land suitable for agricultural activities in the RNS comprising arable land, permanent crops and pasture land amounts to some 4 million feddans or around 16% of total land. The main agricultural areas are those along the River Nile and Atbara River and the basins. Other cultivated areas are mostly patches of fertile land scattered in the eastern and western parts of the State, which in most cases support marginal cultivation and grazing. Over the last two decades, agricultural activities have expanded in marginal lands in the State has marginally increased indicating the scope for potentiality of new land. With limited rainfall, RNS relies on irrigation for optimal agriculture production. Total irrigated land for the RNS amounts to 1,200,000 million feddans, which represents about 30% of the agricultural land. Only the area close to the River Nile is fully utilized under pump irrigation from the Nile and to some extent from underground water, while other major agricultural lands in the high terrace area suffer from lack of adequate investments; a problem, which is worsened by inadequate water supply and land reclamation. Out of the total cultivated area, 114,000 feddan is occupied by perennial crops (74,000

feddan for fruit trees and 40,000 feddan for alfalfa) while the number of date palms amount to about 82,000 trees (MAS, 2009). Generally, this indicates that high opportunities exist to increase the agricultural area, with opportunities for organic farming systems. Organic farming is not yet commercially introduced in RNS but researchers made numerous experiments pertaining to this domain (Figure 2). Based on this background and exactly under these conditions introduction of organic farming system could be regarded as way-out to enhance the quality of environment and tenants' livelihood in the State.

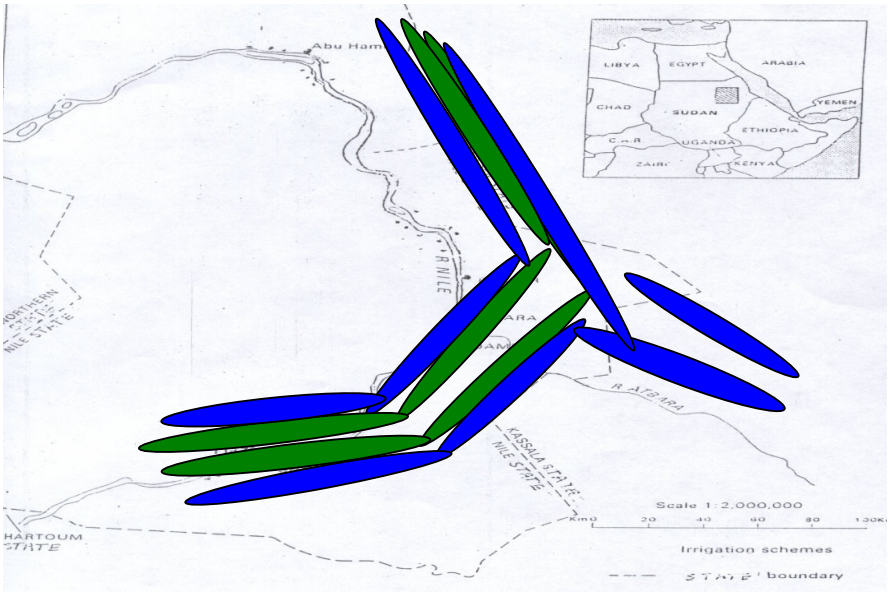

Figure 2: Potentiality of organic perennial crops farms in RNS

	Proposed Organic
	Potential Organic

Source: Ahmed 2009

Productivity in organic systems is management specific. Studies suggest that switching to organic management commonly results in yield reduction of perennial crops (up to 50 percent) and during the conversion period for high external input systems in areas with favorable crop growth conditions (up to 40 percent). However, in regions with medium growth conditions and moderate use of synthetic inputs, organic productivity is comparable to conventional systems (92 percent) and in subsistence agricultural systems, organic agriculture results in increased yields up to 180 percent. Overall, the world average organic yields are calculated to be 132 percent more than

current food production levels (Badgley *et al.,* 2006). The predominant perennial crop combination and its farm area, production and yields of the surveyed tenants are presented in Table 1 and 2.

Table 1: Distribution of Elketiab surveyed tenants according to the area and production of the perennial crops

Crop	Area (fed)	Production (kg)	Crop share of farm area (%)
Dates	1.23	3690	14
Citruses	5.01	17535	58
Mangoes	0.75	1219	8
Guava	1	1050	11
Alfalfa	1.43	8875	15

Source: field survey 2006, AOAD 1998 and ARTC 2007

From Table 1, it is clear that citruses percentage share was 58% of farmers tenancies as the highest percentage over the perennial crop combination, while mangoes was the lowest one. The conventional perennial crop yields achieved by Elketiab surveyed tenants were generally low when compared by research yields attained by the Agricultural Research Corporation (ARC) and conventional perennial's yields, with minimum and maximum yield gap reaching 74% and 26% for date palms and alfalfa, respectively, while the organic perennial crops yields obtained in research were lower than both conventional perennial crop yields and research conventional perennial's yields (Table 2).

Table 2: Distribution of Elketiab surveyed farmers according to the area, yield and production of the perennial crops as compared with ARTC yield

Crops	Yield of Conventional Perennials (00 kg/fed)	Yield of organic Perennials (00 kg/fed)	ARTC Yield (00 kg/fed)	Gap % of Conventional Perennials	Gap % of Organic Perennials
Dates	30	17	65	74	62
Citrus	35	18	60	42	70
Mango	16.25	10	50	68	80
Guava	18	10	60	70	83
Alfalfa	62.06	30	85	26	65

Source: field survey 2006, AOAD 1998 and ARTC 2007

Table 1 also indicates that there is high potential to increase yields of all organic and conventional perennial crops under study. However, the average organic crop yields are often lower than the average conventional yields. Yield differences reflect not only different farming practices but differences in experience. The organic industry is expanding so rapidly that many organic farmers are relatively inexperienced with organic methods. Peter (2008) reported that the most challenging time is the transition period as farmers switch from conventional to organic agriculture. During this period, the price premium is absent and yields are low. Sometimes farmers can receive a minor price premium for transitional production, with a price higher than conventional prices, but lower than the certified organic prices. During the early stages of conversion, some farmers have reported drops in yields of up to 30%. Later, yields tend to increase with the number of years under organic management as farmers gain experience and the soil improves. In Africa, conversion to organic agriculture was estimated to increase

productivity by 56 percent by 2030 (Badgley *et al.,* 2006).

Cost of production for organic and conventional perennial crops

Production economics play a unique role in farm management (Doll and Orzem, 1984).

Organic farming practices can cut production costs as well, according to OCO (2008) that after compensating for an additional nine-hour per acre labor expense, the organic rotation showed a savings of $66/acre in input expenses. At an average of $250/acre machinery expense, the smaller farm saves $93,500 in machinery investment over the conventionally managed farm. The dominant conception of production cost in the area of study is known as the cost of material inputs, labor, services, and the management used in producing a certain goods or/and crops. Many studies showed that the cost of production overall the RNS has led to low profit. The high cost of production is attributed to high cost of numerous production inputs. The RNS farmers complain from high cost of production and they depend on their resources totally for financing their perennial crops by about 600000 SD/fed indicating that the formal financial system was absent. Ijami (1994) mentioned that the formal financial system provides only small parts of credit used by farmers. Therefore, most of farmers seek other informal sources of finance. Loans extended by friends and relatives, mostly without interest, constitute the non-commercial segment. In the commercial segment a range of people like traders, agricultural and professional money lenders operate. Figure 3 reveals that about 12 main cost components constitute the cost of production for perennial crops.

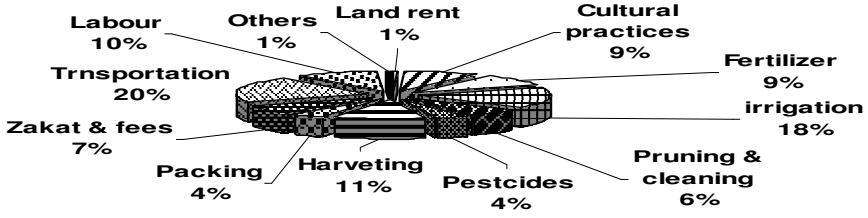

Figure 3: Percentage share of the operation cost items for Elketiab perennial crops

Source: The field survey 2006

Figure 3 revealed that transportation cost component is absolutely considered as the most agricultural hindrance facing perennial crops production, having the highest cost item at 20% of total production cost. This might refer to the inadequate investments in infrastructure. This is followed by the irrigation water cost, which is also regarded as one of the most important agricultural constraints that is caused by the high cost of water pumping; and justifies the need for strict allocation among the different crops grown. The perennials growers in Elketiab scheme pay the cost of this item as a fixed rate for the scheme administration at the end of the year. The following elaboration of the survey results in Figure 3 shows the cost items in terms of conventional and organic perennial crop production operations.

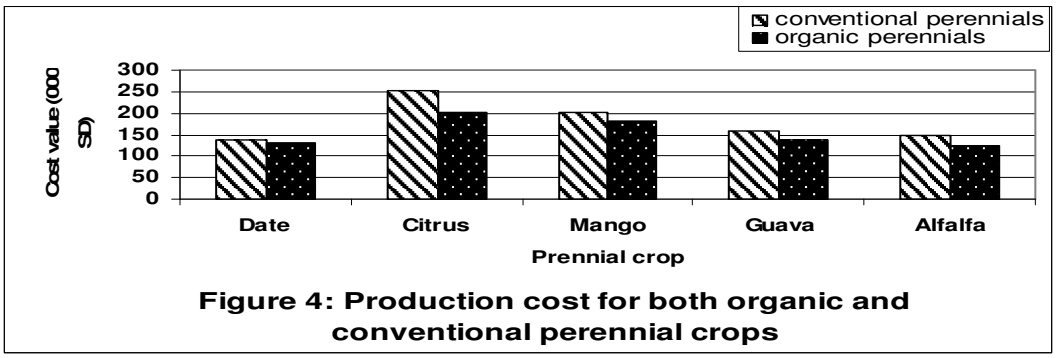

Figure 4: Production cost for both organic and conventional perennial crops

Source: The field survey 2006

From Figure 4 all organic perennial crops under study have lower costs of production than conventional ones, with much less emphasis on purchased inputs. Synthetic fertilizer and pesticide purchases are eliminated. In addition, organic farmers have lower fixed (overhead) costs for depreciation and interest charges attached to capital inputs, such as machinery and equipment (e.g. knapsack sprayers and the like). Further, input costs are lower on organic perennial crops. Organic perennials farming methods replace herbicides with mechanical cultivation and other management practices to provide weed control. Generally, many studies mentioned that in organic agriculture systems, purchased input costs tend to be 40% lower while less irrigation water is needed. Furthermore, organic agriculture could give smallholder farmers the chance to access lucrative commercial markets for organic produce, on condition of course that affordable certification procedures and trading partnerships are established. While certified organic agriculture offers market competitiveness, non-certified organic systems offer advantages for subsistence agriculture, especially in areas where inputs are not available and labour is abundant. In both cases, agroecological knowledge is a precondition, posing the challenge of establishing adequate extension systems.

Analysis of conventional and organic perennials returns

Partial budgeting methods continue to be the backbone of much of analysis on agricultural policy. In their simplest form, budgets provide the evidence that policy makers use to make decisions about private profitability and hence the incentives that farmers have to grow particular commodities. The basic data used to calculate gross returns per feddan are output value (crop prices times' quantity of output, i.e. yield per feddan) from which average total variable cost are deducted to get gross margin per feddan..

Gross margins

Gross margins reveal how much a firm (farm, company etc.) earns to pay for its fixed costs. Gross margin is a good indicator of how profitable a firm 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 fed in SD,
GR: Crop gross revenue per fed in SD and
TVC: Crop total variable costs per fed in SD.

The last decade witnessed that the global demand for organic foods is annually increasing due to consumers' awareness of their value and benefits. Babiker (2003) reported that, Sudan exported 20 plant and livestock food products as conventionally cultivated foods valued at US$305.7 millions. An internet survey for international prices of some organically produced agricultural foods revealed that the difference in price between conventionally and organically produced foods ranges between 38% - 120 %, with an average of 79% increase. This percentage increase in price would be applicable to Sudan agricultural exports if those products were marketed as organic foods. Then they would have obtained total national revenue of US$ 547.2 millions, i.e., an increase of US$ 241.5 millions. In fact those agricultural food products were organically grown but not officially certified by any internationally recognized organization accredited with such certification. The gross margins for conventional and organic perennial crops under study also were assessed individually per feddan and the results were expressed in Sudanese Dinar (SD) as discerned in Table 3.

Table 3: Gross margin analysis for conventional and organic perennial crops (SSD*)

crop / Items	Dates		Citruses		Mangoes		Guava		Alfalfa	
Perennials	Conv.	Organ.	Conv.	Organ.	Conv.	Organ.	Conv.	Organ.	Conv.	Organ.
Productioncost (SD/fed)	139224	131197	251704	202299	203120	181537	158506	138506	147549	124870
Average yield (kg/fed)	3000	1700	3500	1800	1625	900	1800	1000	6206	3000
Average price (SD/kg)	48	86	80	142	150	278	110	190	26	48
Gross returns (SD/fed)	144000	146200	280000	255600	243750	250200	198000	190000	161356	144000
Gross marginal Revenue (SSD/fed)	4776	15003	28296	53301	40630	68663	39494	51494	13807	19130

One SSG= 100 SSD* Source: The field survey 2006

Table 3 illustrates that gross margins of both conventional and organic perennial crops were positive, but organic perennial crops enjoyed higher gross margins. The high returns applicable to organic perennials compensate for their low yields, and with yield improvement of organic perennials, still higher gross margins can be obtained. In general, expenses are lower and the income is greater (due to the price premium). Price premiums vary between crops and over time. On the other hand organic production is changing rapidly, leading to price instability. For example, a high premium price for one crop can lead many tenants to grow that crop, which might depress prices. Thus tenants' awareness is needed about marketing issues within the promise offered by organic farming.

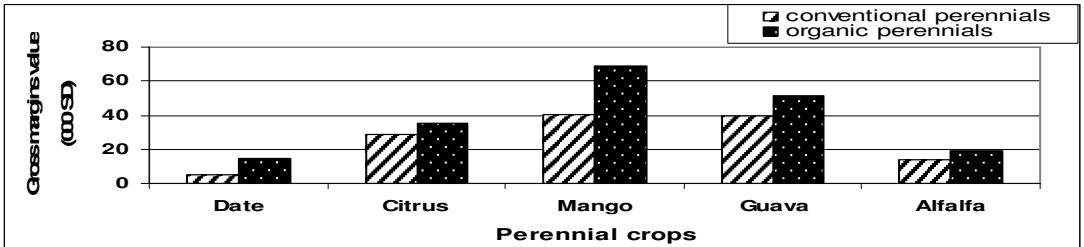

Figure 5: Gross margins of organic and conventional perennial crops

Source: The field survey 2006

From Figure 5 the gross margins from mangoes was the highest one, followed by guava, citruses and alfalfa for both conventional and organic perennials, while the gross margin of both conventional and organic date palms was the lowest.

Marketing of conventional and organic perennial crops in RNS

Trade in organic products is a new area whereby Sudan can realize additional export earnings and enhance farm incomes, food security and rural development. Estimated at 10-12 billion US$ annually, trade in organic products worldwide is increasing rapidly. It is estimated to reach 80 billion US$ by 2008. Most of Sudanese commodities are free from chemical contamination and could be sold as organic products provided the necessary infrastructure and procedures are put in place (Adam, 2008). The world organic market is growing at a rate of 20 percent per year. It is a clear fact that organically grown food in Sudan will have a wide-open door in the international market reaching much higher prices and consequently more national revenue. Farmers cultivating those food products will also get more income, which will be positively reflected on their standard of living. More national revenue means more money available for solving pertaining problems hindering Rural Development. Marke-ting such large amounts of organic foods will make Sudan a prominent figure in the international market of these products. It will also attract global investors to agricultural production of such crops (Babiker, 2003).

Over the last decade RNS witnessed improvement in crop marketing due to some progress in road infrastructure. Although there are numerous linkages and options for marketing of perennials' products, tenants still face some difficulties to take the right decision of where and when to make their sales. The hesitancy of RNS tenants might be attributed to the high cost and difficulties of transportation, which forms the highest marketing cost item, in addition to the fees along roads for accessing big city markets. Furthermore, lack of some marketing infrastructures such as cold storage are considered as chronic hindrances facing perennials producers in Elketiab, which usually compel small tenants to sell their produce immediately after harvest at very low farm gate prices for big farmers or traders. The study revealed that more than 50% of Elketiab tenants prefer to sell their crops in nearby markets, while 46% of them take their crops to Khartoum state markets, which are about 250 km away. It is observed from this research that the means of communication became essential tools in the area of study where they play an important role in reducing marketing cost and, to some extend, in raising farmers' awareness about urban markets. The

tenants in the area of the study reported that they depend on mixed sources of market information such as market centers, wholesalers and the agricultural office of the scheme.

Based on this fact, RNS will need to establish its organic perennial production considering international options of this industry and gradually follow a robust plan to pursue successive amendments. This would enable the State products to be exported as organic. However, the existing non-compliance with the strict standards and specifications would require considerable time and resources before the State can enter the international market of organic perennial products. Adam (2008) summarized that trade in organic products is handicapped by many constraints, including: (1) Absence of a national organizing body to oversee the whole range of issues of the supply chain, (2) Lack of awareness of farmers of the opportunities in international markets, (3) Low productivity and high costs of production due to lack of improved technology, weak extension services and lack of finance, and (4) Poor infrastructure and inadequate marketing system.

Contribution of perennial crops in household food security and income

Although RNS farmers exert tremendous efforts all over the growing seasons and dream of a successful harvest, they end up disappointed by unfavorable prices. Given limited infrastructure, this leads to the quick sales mentioned above, but they nevertheless distribute the disposal of part of their produce over the remaining part of the season as shown in Table 4.

Table 4 Distribution of disposal of perennial crops quantities in Elketiab scheme

Crop	Production (kg/farm)	After harvest sale (%)	H.H consumption (%)	Future sale (%)
Date	3690	55	15	30
Citrus	37900	90	2	8
Mango	1163	85	15	-
Guava	1050	80	20	-
Alfalfa	8568	19	81	-

Source: The field survey 2006

Decisions on marketable surplus quantities either to be sold immediately after harvest or/and for future sale depend on the crop after devoting a certain amount for household consumption as depicted in Table 4. The surveyed farmer reported that only two crops could be kept for future sale, namely palm dates and citruses. Elketiab farmers store citruses on trees for 3-5 months after maturity and they sell them when prices improve. It is derived that 2214 kg of dates and 3778 kg of citruses production are allocated either for storage or future sales. Also 81% of alfalfa production is considered for household consumption while the rest is regarded as marketable surplus. For the other crops (mangoes and guava) the produce usually goes to market after devoting some quantities for household consumption as shown in Table 4.

While the expected contribution of organic perennials to household nutrient intake can be promoted by diversifying and optimizing farm productivity, reducing the need for purchased inputs and, eventually, developing households marketorientation for earning additional income, will be conducive to organic systems contributing to hunger and poverty alleviation. According to Peter (2000), every 10 percent increase in crop yield reduces the number of income-poor by an average 7.2 percent in sub-Saharan Africa. Improved income allows farmers to buy food in what would otherwise be hungry months.

Harnessing the lucrative gains that come from marketing organic commodities can allow seasonal or permanent diversification away from staples into high-value alternatives such as vegetables, depending on the degree of physical and human capital investment and agro-ecosystem flexibility. Numerous studies reported that although in most cases, staple food systems will remain dominant sources of food supply and off- farm activities are more dependable sources of income, organic diversification offers higher returns from land and labour investments. However, the diversification start-up is often associated with high-price volatility which needs to be countered with improved marketing intelligence.

Income sources of the surveyed tenants

Most of farm studies confirmed that diversifying income sources opportunities might enhance farm sustainability. The most common source of tenants' income is the sale of produced crops and livestock and other products raised or bought for resale. Off- farm income is still one of the principal options for Elketiab tenants to meet their farm and household expenditures. The main off-farm sources in study area are mainly remittances and contributions of the family members, formal employment, trade, and other off-farm private activities as portrayed by Table 5.

Table 5: Farm and off-farm income sources of Elketiab surveyed tenants

Source of income	Value (SD)	Farm income (%)	total of (%)	Tenants (%)
Source of farm income:				
• Perennial crops returns	1870280	78	-	-
• Seasonal crops returns	396533	17	-	-
• Livestock returns	107059	05	-	-
Total average of in-farm income	2373872	100	82	32
Total average of off-farm income	522700	-	18	68
Total average income of tenants	2896572	-	100	100

Source: The field survey 2006

The results of Table 5 reveal that 68% of Elketiab tenants earned off-farm income beside their farm income, while 32% of the total surveyed tenants relied only on farm returns from their main sources of activities as depicted in Figure 6.

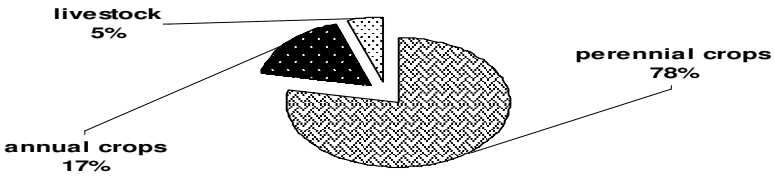

Figure 6: Sources of farm income for Elketiab surveyed tenants

Source: The field survey 2006

Figure 6 also shows that farm income accrues mainly from three sources: perennial crops providing the highest farm returns (78%) followed by annual crops (17%), and 5% from livestock as the lowest one. This confirms the importance of perennials in shaping the tenants' income in area of the study. In case of organic producing farmers, the majority diversify their businesses by growing several crops at one time, often having both livestock and field crops, and sometimes value-adding enterprises as well. The diversification

reduces economic risks. As well, enterprise diversification makes it easier for farms to be more self-sufficient in terms of nutrients, livestock feed, soil organic matter and energy. Many experienced organic farmers have crop yields as high as, or higher than, the average conventional yields.

Optimal perennials production obtained by RNS model

Secured land and water-use rights are more important preconditions for investments in organic diversification and commercialization than for other forms of agriculture. Organic background of RNS tenants for growing conventional perennials, annual crops and animal breeding offer a promising option for improving the farm system and livelihood of people both in rural and peri-urban areas.

The received information from the model run is the objective function value (returns), the optimal crop combination, and utilized resources accompanied by their respective marginal value productivities. The analysis also provided some other relevant results as shown in Table 6. The Table also presents the actual and optimal cultivated area for the different perennial crops and gives also the optimal allocation for the average area. The optimal solution reflects devoting land only for citruses, mangoes and alfalfa as 4, 2, and 4 fed respectively, while the rest of the crops didn't appear in the optimal plan. The actual returns from crop production are SD 134998, while the optimal returns are SD 427050 which is more than the actual returns by 68%.

Resource use and constraints

The last decades witnessed increased interest to grow perennial crops overall the RNS, and that might be due to the higher prices or the low operation costs of those crops when compared to the annual crops according to their duration on land. Many studies mentioned that the higher prices for perennial crops have enhanced incentives to grow them. Moreover, growing of perennial crops allows intercropping with some crops, particularly alfalfa. According to the mentioned characteristics of the perennial crops, resources use and availability might be under competition.

Table 6: Scenario: Proposed cropping pattern plan for organic and conventional perennial crops in RNS

Item	Actual	Optimal	Units
Resources use:			
Total land	10	10	Fed
Total irrigation water	131256	122976	Cubic meter (m^3)
Total labour	106	84	Man-day
Total capital	1675200	1675200	SD
Returns: objfn value (Z)	134998	427050	SD
Cropping pattern:			
Conventional Date	1	-	Fed
Conventional Citrus	1	-	Fed
Conventional Mango	1	-	Fed
Conventional Guava	1	-	Fed
Conventional Alfalfa	1	-	Fed
Organic Date	1	-	Fed
Organic Citrus	1	4	Fed
Organic Mango	1	2	Fed
Organic Guava	1	-	Fed
Organic Alfalfa	1	4	Fed

Source: Model results, compiled data 2006 and 2010

From Table 6, the optimal and actual quantities of capital used for the different perennial crops under the study are SD 1675200 and SD

1675200. It is clear that the optimal plan resulted in all available land and cash to be devoted to organic perennial crops (citruses, mangoes and alfalfa), while the optimal and actual water used are 122976 m^3 and 131256 m^3 respectively. The optimal level of hired labour amounted to 84, forming 79% of the total available labour. In the optimal plan, 122976 m^3 of the total water would be used, which is 94% of total available water. The monthly distribution of labour in the optimal plan is 7 man-days, forming 78% of total available labour. At the optimal crop combination, the monthly distribution of actual available cash to finance the perennial crops was SD 13960 allocated annually over the months, forming to 100% of the total available capital.

Conclusions and policy implications

The paper demonstrates that RNS boasts of high opportunities to take lead in the production of organic perennials due to its many advantages such as availability of stable and high quality irrigation water (RN), suitable environmental conditions (alluvial soil and favorable climate leading to outstanding yield and fruit quality), accumulated experiences of farmers, and strategic geographical location of the State. Although RNS is regarded as one of the famous agricultural states over the country, it is still lagging behind in adopting organic crop production. One of the main findings of the field survey is that perennial crops in RNS are well-established and are economically important products. A major obstacle to expanding and realizing the potential of perennial crops is the high cost of establishing new plantations and the recurrent cost of financing crops for four to five years before any significant production can be realized. Finance provision for these crops is absent in the area of study. The study unveils the low productivity of the organic perennial crops that form promising strategic crops. Encouraging policies imply reducing the cost of production or providing incentives to the organic perennials growers of the State by buying their products at reasonable prices. Based on these facts and the obtained results, the study concludes that:

- The potential for organic perennial farms production in the RNS is quite promising on account of the huge natural resources and the wide range of biodiversity available with high relative advantages.
- Establishment of organizing and certification bodies and developm-ent of national regulation for certified organic perennial crops production, handling, processing and marketing can be useful for implementation and sustainability of organic perennials farms in the RNS.
- Encouragement of some internat-ional companies with good history and long experience in production and marketing of proposed organic products to sho-ulder the responsebility and foster organic agricult-ure in the State.
- Because basic services are regar-ded as one of the chronic const-raint facing agricultural production in area of the study, intervention is needed to establish infrastructures (i.e., roads, stores, processing stations).
- Spreading organic perennial cult-ure among producers, processors and exporters of RNS is important, and here extension will be of fundamental importance to build agro-ecological knowledge. The fact that organic agriculture emph-asizes multi-, rather than mono-cropping is also important in terms of food security, which can be jeopardized when farmers produce

a single commodity and have no safety net to fall back on.

- Relevant stakeholders' intervenetions are needed to transfer improved technologies to increase farm productivity; in addition, the RNS tenants also need to be encouraged to produce organic perennial crops as high value crops when designing crop combination.
- Improving finance institutions will enable the RNS tenants to improve their resources use and significantly increase their perennials farm returns.
- Appropriate combination of land, water, labour and capital resources for producing organic perennial crops combined with the other conventional perennial crops in RNS is very important and should be well designed and applied.

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