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Economic Aspects of Potatoes Production in North Sudan

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Abstract

Potatoes crop in River Nile State (RNS) of Sudan has received limited development efforts over the past few years. The crop is one of the most potential crops in area of the study that can attain this purpose. This study looks to assess the potatoes economic aspects in the State. It depends on both primary and secondary data. The partial budgets for potatoes were estimated separately for all actors and players to visualize the important factors affecting the yield and returns of potatoes. The respondents distributed over four major localities namely, Shendi, Elddamer, Atbara and Berber specializing in potatoes production by using structured interview questions and researcher's observations. The study findings illustrate that, potato is important strategic crop that combats malnutrition in the country and the major constraints that faced potatoes were shortage and instability of power as well as the high cost of production inputs. Finally, to tackle these hindrances, preparation of good and shared policies between public and private sector would improve the crop production and livelihood of producers.
Keywords: *potatoes, economics, production, north Sudan*

الجوانب الاقتصادية لإنتاج البطاطس في شمال السودان

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المستخلص

تلقى محصول البطاطس في ولاية نهر النيل في السودان جهودًا إنمائية محدودة خلال السنوات القليلة الماضية .يعتبر المحصول من أكثر المحاصيل الواعدة في منطقة الدراسة والتي يمكن أن تحقق عوائد مجزية .تهدف هذه الدراسة إلى تقييم الجوانب الاقتصادية للبطاطس في الولاية . تعتمد الدراسة على كل من البيانات الأولية والثانوية .تم تقدير الميزانيات الجزئية للبطاطس بشكل منفصل لجميع الجهات الفاعلة واللاعبين لتصور العوامل المهمة التي تؤثر على المحصول وعوائد ه . توزع المشاركون على أربع مناطق رئيسية وهي شندي والدامر وعطبرة و بربر من المتخصصين في إنتاج البطاطس باستخدام أسئلة الاستبانات المنظمة وملاحظات الباحث الشخصية. توضح نتائج الدراسة أن البطاطس محصول استراتيجي مهم يكافح سوء التغذية في الدولة، وكانت المعوقات الرئيسية التي واجهت زراعة وانتاج البطاطس هي نقص الطاقة وعدم استقرارها بالإضافة إلى ارتفاع تكلفة مدخلات الإنتاج .أخيرًا ، لمعالجة هذه العوائق ، فإن إعداد سياسات جيدة ومشتركة بين القطاعين العام والخاص من شأنه تحسين إنتاج المحصول وسبل عيش المنتجين.

كلمات مفتاحية: البطاطس، اقتصاديات، انتاج، شمال السودان

Introduction

Historically, Sudan's economy depends on agricultural sector; it employs 65% of the workforce and forms about 38% to its GDP (Abdallah, 2012). Although Sudan is extracting oil and gold but the economy of the country is still looks agro-based, where more than 70% of population directly or indirectly dependents upon agriculture. In spite its essential in the economy, agricultural sector is still lag behind than its potential level. Predomination of small holdings, inefficiency of resources use with high cost of production and inadequate agricultural finance are the main causes responsible for low crop productivity that justify why most of the farmer prefer vegetable and annual crops to gain a rapid return. In Sudan, potatoes have characterized as a high yielding crop and the area under potato has stretched from 7,000 feddan (0.42 hectare) in 2004 to 31,000 feddan in 2007. The average yield of the crop ranged between 3-12 ton/feddan according to the crop variety, climate, farm technical practices and others (Ministry of Agriculture Animal wealth and Irrigation, 2007). Potatoes crop is the fourth important crop in world after rice, wheat and sorghum as the most edible and consumed crops in the world (Singh et. al. 2004).

The River Nile State of Sudan boasts of huge agricultural resources that made the state a potent and promised for potatoes production. The River Nile State enjoying about four types of farming systems, these types were according to the type of the agricultural activities. These systems were namely, private, cooperative, public and foreign investment irrigated schemes. The selection of the River Nile State was based on the farming system pattern and the dominant crop combinations that represented by annual field crops as well as it large arable fertile areas that occupied by large number of farmers. The location of River Nile State is about 300 kilometers north Khartoum (Figure 1), the district has chosen rather than whole of the north region to save time and money. Potatoes crop in the State depends mainly on surface irrigation from River Nile. The predominant climate there is relatively cool in winter season; it always extends from October to March. The state is enjoyed with alluvial fertile soils, while the environment is rather favorable for producing relatively high-value crops compared to other states of the country. The crop is grown in the state in the winter season, it begins in November and continues to March, it prevailed along the River Nile banks as well as in the islands existed along the River Nile. Potato crop in the State is commonly produced under irrigated sector from the River Nile. The crop production and marketing in the state is faced by numerous constraints such as high cost of production, lack of certified seeds, diseases and blights, remoteness of cold storage facilities, prices fluctuation and inadequate market system. Finally, this research aims to assess the economic aspects of potatoes in the State. Specifically, it looks to illustrate the challenges and the main factors that constraining potatoes production and development and facing to achieve yield improvement and full commercialization, also to examine routes for sustainable change in potatoes farming system and that increase market opportunities in the area of the study.

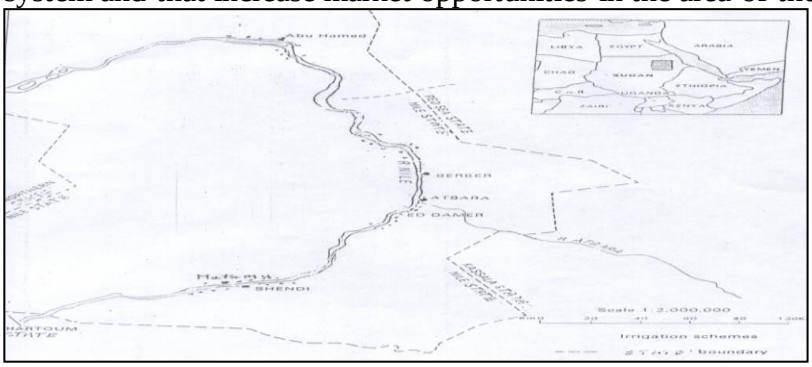


Figure (1) Map of the River Nile State of North Sudan Source: Ahmed 2004

Methodology

The study collected primary data and secondary information. The primary data collected by using structural questionnaires, it was largely qualitative, using key informant interviews and observations. The primary data covered technical, social and economic aspects of potatoes production in area of the study.

Analytical techniques

Qualitative analysis was used; it was chosen because there is little quantitative data about the potatoes marketing in the area of the study. Generally, a set of techniques were applied to achieve the goals of the study. Descriptive statistical analysis and partial budget analysis were used. This research is based on in-depth respondents conducted in River Nile State in Feb. 2018. The surveyed potatoes growers and actors took place in four localities in the State, namely Shendi, Eddamar, Atbara and Berber. The selection of potatoes actors was based on their involvement and expertise in potatoes production and business.

Partial budget analysis

Statistical tools were used to analyze the main cost items of potato production to determine the significant variables. According to Haddad (2000) there are three broad types of situation in which budgeting may be called for: (a) A comparatively minor change in practice, (b) A drastic change in farming, and (c) Starting up on a new farm.

Table 2 shows the calculation of partial budget analysis according to the following criteria:

1. The gross revenue (GR); was calculated by multiplying the farm gate price of the crop by the crop yield,
2. Total variable costs (TVC); is calculated by multiplying the quantity of input (material or practice) used by its price,
3. Gross marginal revenue (GMR); was calculated by subtracting the gross revenues minus the total variable costs. The difference in gross marginal revenues of adopters and non-adopters indicated the net monetary return that resulted from use of the technology. The general mathematic expression is:

   Gross marginal return = Gross revenue - total variable costs

GMR = GR – TVC …… (1)

Where: GMR Gross marginal return (revenue),

GR Gross revenue,

TVC Total variable cost

The study also applied partial budget analysis to assess the cost and returns of the crops under the study. The basic data used to compute gross returns per fed are output values, while gross margin per fed was calculated by subtracting the average total operation cost (variable costs) from the average total returns. 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, and

TVC: Crop total variable costs per feddan in SDG.

Results and Discussion

In Sudan, the recent state policies addressed agricultural production development and became one of top priorities to meet the demand of rapid population growth, increasing agricultural products export and boost producers' returns. The River Nile State (RNS) of Sudan is characterized by a relatively unique cool winter compared to the rest of the country. This makes

the State one of the most suitable states for producing winter-season crops. The design of a seasonal crop combination for each season especially the winter season in RNS is considered as a key factor to obtain a successful production and farms sustainability. The predominant winter season crops in the State are mainly cereal, vegetables, fodders and legumes crops. Abdel Magid (1991) mentioned that, the performance of legumes and annual cereal intercropping varied by intercrop pattern.

The total area of the River Nile State is estimated at 129.744 km^2 (30 million fed) out of which about 9,500,000 feddan is a categorized as agricultural arable land, while the current invested land is about 1,200,000 feddan and 3,249,000 fed is certified land for agricultural investment and suitable for multi agro-activities and crop production (Table 1). On the other hand, the State is one of the relatively rich states in the country with water resources. The main direct resources of irrigation water in RNS are the River Nile, Atbara River, underground water and rains as shown in Table 1.

Table (1) Potential of fundamental agricultural resources (land, water) - RNS

Land resources	**Area (**feddan**)**	**Water sources**	**Water amount**
Agric. Arable land	9,500,000 feddan	River Nile along the RNS	670 km^3
Certified land	3,249,000 feddan	Atbara River	200 km^3
+Invested land	1,200,000 feddan	Underground water aquiver	3,16 milliard m^3
Forest land	209,000 feddan	Surface water & valleys from rains	1, 490 milliard m^3 and 57 valley
Natural pasture land	48,000 km^3		

Source: Annual Report of Ministry of Agriculture in RNS - 2018

However, this research revealed that the performance of resources management for agricultural production in the state is indicated existing of production potent and area gap between the targeted and cultivated areas in RNS for season 2017/2018, this might be due to resources misuse and inefficient management as shown in Figure (2).

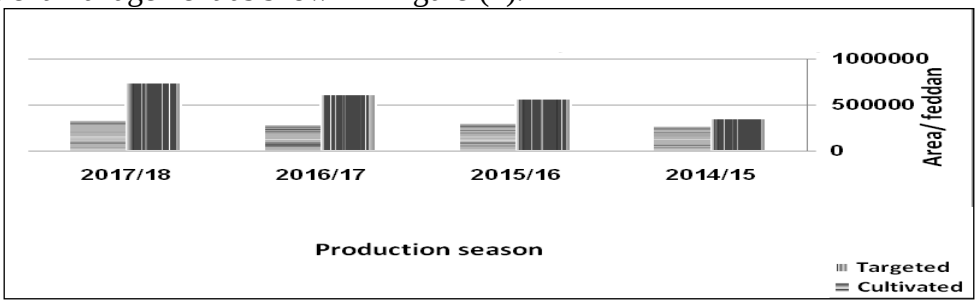


Figure (2) Potential and gap between the targeted and cultivated areas in RNS

Source: Report of Ministry of Agriculture in RNS season 2017/2018

Socio-economic characteristics of main production players in the State

The study undertook an analysis of some socioeconomic characteristics including mainly locality, occupation, age, education level and experiences for the surveyed potatoes producers. The underneath table (Table 2) represents these characteristics.

Table 2: Socio-economic characteristics of potatoes producers in the State

Variable		Producers	
Locality	Items	Frequency	Percent
	Shendi	24	54.5
	Alddamer	15	34.1
	Berber	5	11.4
	Total	44	100.0
Occupation	Yes	36	81.8
	No	8	18.2
	Total	44	100.0
Age	Less than 20	0	0
	21 – 30	3	6.8
	31- 40	11	25.0
	41 – 50	10	22.7
	51 – 60	12	27.3
	More than 60	8	18.2
	Total	44	100.0
Education Level	Khalowa	3	6.8
	Primary	16	36.4
	Basic	7	15.9
	Secondary	18	40.9
	University	-	-
	Total	44	100.0

Source: field survey, 2020

Locality: The study revealed that 54.5% of potatoes growers of the crop value chain live in Shendi locality, while Elddamr showed 34.1% and Berber just 11.4%. *Occupation*: Table 2 unveiled that 81.8% of the producers mentioned that their basic occupation is agricultural activities and 18.2% of them have additional work. *Age*: The research unveiled that the majority of producers were under the category of age groups 31 – 40 and 51 – 60 which are the most active group while the others were found as less than 20 and more than 60 represented less share. *Education level*: The results showed that 40.9% of the producers have attended secondary school and 36.4% basic school, it's noticed that only 6.8% were *"khalowa"* that indicated high awareness of the producers in cultivation potatoes in the State. *Experiences*: The study unveiled that the average experience years for producers, wholesalers and retailers were 12.2, 18.0 and 14.6 years respectively.

Potatoes growers in River Nile State

Small-, medium- and large-scale privates producers and big companies; tenants in quasi-government schemes; mostly traditional production concentrated along the River Nile banks as well as in eastern, central and western States of the country. Potatoes are grown mainly by vegetables farmers, average allocated area for potatoes is found as 17.43 fed per producer of the River Nile State. The most famous districts that produce potatoes in River Nile State were namely, Altragma, Alkityab, Almtama, Alsnahir Alnyha island, Almosiab and Alzidab, while the

most common variety grown called Zafera and Billini and the average yield of potatoes achieved by the crop growers was about 166.43 sack/fed (45-50 kg each).

Table 3: Distribution of producers according to type of land, seeds and finance

Variables		Producers	
Land tenure type	Items	Frequency	Present
	Owner	12	27.3
	Rent	31	70.5
	Share	1	2.3
	Total	44	100.0
Type of Potatoes seeds input	Local	20	45.5
	Imported	5	11.4
	Local & Imported	19	43.2
	Total	44	100.0
Sources of potatoes seeds	From market	17	38.6
	Cold store owner	9	20.5
	Seeds company	14	31.8
	Wholesalers	1	2.3
	Agricultural Bank	3	6.8
	Total	44	100.0
Sources of finance	Self-funding	26	59.1
	Share	10	22.7
	Agricultural company	2	4.5
	Agricultural Bank	4	9.1
	Friends and relative	1	2.3
	Other	1	2.3
	Total	44	100.0

Sources: field survey, 2020

Table 3 shows some of essential inputs of potatoes including land tenure type, potatoes seeds input, sources of finance, sources of potatoes seeds.

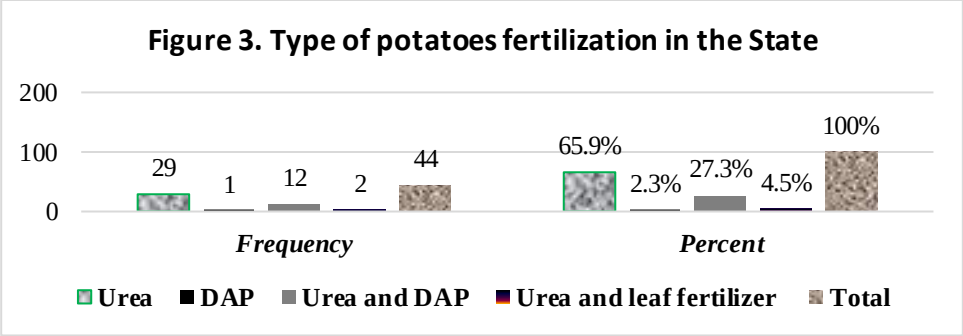
Land tenure type: according to Table 3 that 70.5% of land was rented and 27.3% was owned, while only 2.3% of the land was shared.

Type of potatoes seeds input: The research revealed that the greatest portion of producer's (45.5%) preferred locally produced seed tubers varieties from market, while about 43.2% of them planted locally produced seeds mixed with imported seeds, and the minority of the producers (11.4%) planted imported seed tubers, due to its high prices (see Table 3).

Sources of potatoes seeds: From Table 3, about 38.6% of the potatoes producers obtained their seeds from the local and central markets, while 31.8% of them have obtained it from Seeds Companies and a few of them obtained it either from cold storage owners or Agricultural Bank of Sudan (ABS) for 20.5% and 6.8% respectively (Table 3).

Sources of finance: The study unveiled that 59.1% of the producers under the study were reported as self-finance while 9.1% of them have received finance from the Agricultural Bank of Sudan (ABS) due to complicated procedures at financial institutions in the country.

Type of potatoes fertilization in the State: Figure 3 illustrates some types of fertilizer that applied by potatoes growers in the State.



The figure shows that the majority of producers (65.9%) used Urea while 27.3% of them used Urea mixed with DAP and 4.5% of them used Urea with leaf sprayed fertilizer and only 2.3% of them used DAP only.

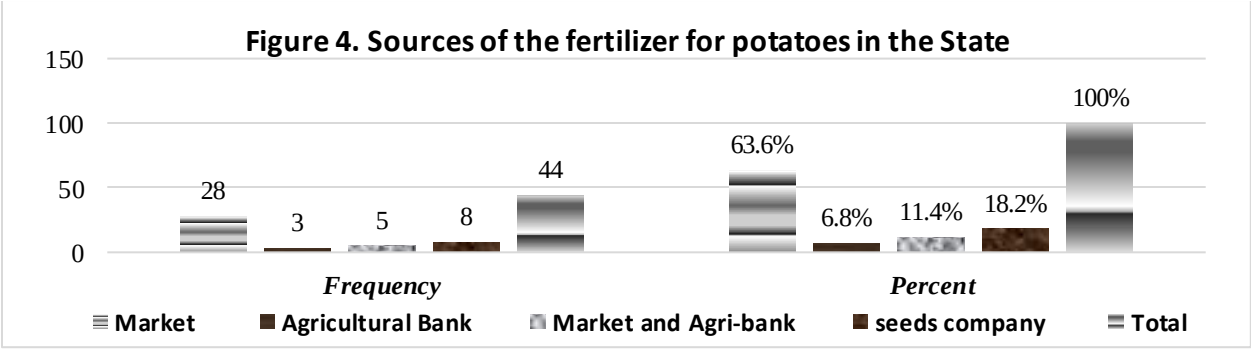
Sources of the fertilizer for potatoes: From the Figure 4 that 63.6% of the potatoes producers obtained fertilizer for potatoes from local and central cities markets, while 18.2% them brought it from seeds companies, and 11.4% from the market with agricultural bank and only 6.8% of them obtained it Agricultural Bank.

Table 4: Distribution of the fertilization of potato according to quantity & prices (sack/fed)

Variable	Fertilization	
	Mean	SD
Quantity (sack)	4.06	1.917
Prices (SDG)	1566.27	289.000

Sources: field survey, 2020

On the other side Table 4 depicts the distribution of fertilization for potatoes crop according to quantity and prices (sack/fed) in River Nile State.



Sources: field survey, 2020

From Table 5 that the highest cost component recorded was for seeds which accounted for 59.79% of the total costs, while 10.01% for the fertilizer and 9.22% for land rent.

Table 5: A Partial budget for potatoes crop (SDG/fed) in the State

Revenues and costs	Mean (sack/fed)	(%)	Mean (for one ton)
Revenues:			
Productivity (sack/fed)	166.43		1.00
Prices of potato (SDG/ sack)	600.11		12,000
Return of potato (SDG/fed)	**99,876.30**		12,000
Total of revenues (SDG/fed)	**99,876.30**		**12,000**
Costs:			
Rent	5854.54	9.22	p.
Seeds	37982.81	59.79	p.
Fertilizer	6359.05	10.01	p.
Tilling	1271.48	2.00	p.
Total production cost	**51467.88**		**6185**
Prepare	1131.73	1.78	o.
Cultivation	1757.73	2.77	o.
Weeding	1619.68	2.55	o.
Irrigation	757.73	1.19	o.
Harvesting	3008.95	4.74	o.
Transport	3072.27	4.84	o.
Load	684.20	1.08	o.
Taxes	30.57	0.05	o.
Total operation cost	**12062**		**1450**
Total costs (as a proxy for purchase price)	**63,530.74**		**7,634.529** **(**Total costs for one ton)
Net Returns	**36,345.56**		**4,365.471**

Sources: field survey, 2020

Potatoes storage in River Nile State

The research has considered some factors that affects cold storage management such as type of the storage and area of the crop production, in addition to the location of the suitable markets that intake the surplus of potatoes as well as sources of crop purchase and showed who sell the crop and who provide finance to potatoes growers to obtain their crops after harvest.

Type of cold storage ownership: For the cold storage ownership in the area of the study, the results showed that 100% of the cold storage owned by wholesalers of potatoes in the State. The research revealed *locations for production potato crop*: it shows that 50% of the cold storage owners from Almhmia and Berber locality, and 50% of them same percentage from Shendi and Elddamr, while the *markets of potatoes in the State* were included cold storage that receive potatoes directly from potatoes producers as well as from central markets of the State such as Almhmia, Berber, Shendi and Elddamr of the State. The study unveiled that the main *sources of potatoes crop to be purchased by cold storage owners in the River Nile State were* found that 50% of the cold storage owners purchase the crop from trade in the markets, while 50% of them purchase it from other producers. It's clear that there are different sources to purchase the crop in the area of the study. In addition, the research found that the *main buyers of potatoes* were

wholesalers. This means that the cold storage owners deal with the high quantity and big sizes of potatoes marketable surplus. The research also evaluated the impacts of actors finance on potatoes marketing, it showed that 50% of the cold storage owners finance potatoes producers under the condition including future contract to obtain the crop after harvest, while 50% of the cold storage owners did not use future contract with potatoes growers in the State.

Table 6: Distribution cold storages capacity and withdrawn quantity per month (sack**)**

Variable	**cold storage owners**	
	Mean	SD
Capacity of cold storages (sack)	1250.00	353.553
Withdrawn quantity during a month (sack)	300.00	282.843

Sources: field survey, 2020

Table 6 depicts the distribution of cold storage owners for capacity of their cold storages (sack), and also it shows the withdrawn quantity during a month per sack in River Nile State.

Marketing channels and marketable surplus of potatoes in the State

The markets in River Nile State include different types of actors, one of them is wholesaler who works as intermediary between producers/traders and retailers. Wholesalers usually assemble the crop and sell it in central or town markets, sometimes he sells on an auction basis and the supplier (farmer or trader) and buyer (retailers) pay a particular fee to the wholesaler. The wholesaler is an intermediary who does not sell to the public. In the State the wholesalers buy potatoes crop from the potatoes growers and central markets of the State then sell it to potatoes retailers and cold storage owners and pass up the crop to potatoes processors and sometime to exporters. Most of potatoes wholesalers attend in the crop markets at production areas at post-harvesting periods aiming to know prices of the crop.

The study revealed a set of activities concerning potatoes wholesalers' activities in River Nile State. It depicts *the main locations of potatoes production in the State* were found as 63.2% of the production potatoes in Shendi locality, while the other locations namely, Almhmia and Elddamr recorded 21.1% and 15.8% respectively. The study evaluated *the main markets of potatoes for wholesalers in the River Nile State were* Shendi and Elddamr for 36.8% and 26.3% respectively, while the other markets such as Atbra and Almhmia formed only 10.5%. In addition, the research depicted the *main buyers of potatoes* were cold storages owners, wholesalers and producers buy potatoes by 42.1%, 31.6% and 26.3% respectively. The mentioned actors contribute in *determination of potatoes prices in the state specially* the cold storages owners who control the prices by 47.4%, while the rest percentages 26.3% and 15.8% were allocated for producers and brokers respectively. Generally, the *mechanism of determination of potatoes prices in the state* is based on the marketing prices forces by 52.6% and 47.4% formed by quantity and quality of potatoes crop. The study revealed that the main *Sources of information about market prices* were distributed as 52.6% for wholesalers and 36.8% for cold storages owners and the *wholesalers intend to sell potatoes in markets* for retailers by 89.5% that means the majority of the sold potatoes go to the retailers, while only 10.5% of them goes to the other wholesalers. Finally, the *determination of potatoes selling prices* were found 57.9% determined by marketing prices forces and 42.1% according to quantity and quality of potatoes.

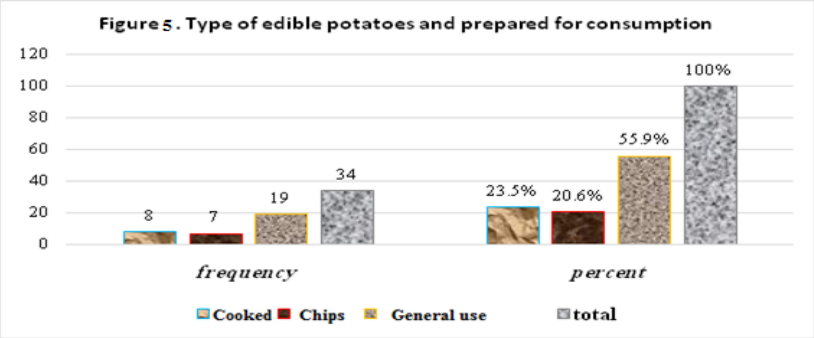
The research also emphasized on other marketing activities that undertake be retailer. In River Nile State, various, ranged from simple small shop and street retailers in village and town

markets to modern shops in big towns. Source supplies from wholesalers or directly from production areas in case of some modern retailers. Potatoes retailers are considered as essential actors in potatoes markets of the State. They mainly receive the crops from the crop wholesalers in the central markets of the State namely, Shendi, Atbra, Elddamr and Almhmia, and the next chain for retailer is always the consumers who usually by the crop in a Kilogram unit. The study unveiled numerous results with concern to retailers' activities similar to that of potatoes wholesalers' activities in River Nile State consisting locations of potatoes production, main markets of potatoes in the State, main buyers of potatoes, determination of potatoes prices in the state, mechanism of determination of potatoes prices in the state, Sources of information about market prices, main actors who willing to buy potatoes in the State markets and Determination of potatoes selling prices. The study found that *the main locations of potatoes production in the State* were found as 62.9% of the production potatoes in Shendi locality, while 22.9%, 8.6% and 5.7% formed by Atbra, Elddamr and Almhmia respectively. The study evaluated *the main markets for retailers where they buy the crop in the River Nile State* were Atbara central market by 63% and 18.5% recorded for Shendi and Elddamr for each one. In addition, the research depicted the *main buyers of potatoes* were wholesalers and cold storages owners buy potatoes by 91.4% and 8.6% respectively. The mentioned actors contribute in *determination of potatoes prices in the state specially* the wholesalers who control the prices for retailers by 97.1%, while only 2.9% percentages were allocated for retailers. This indicates that the retailers depend on wholesalers to determine potatoes prices in the State markets. Generally, the *mechanism of determination of potatoes prices in the state* according to retailers' response is based on the marketing prices forces by 62.9% and 37.1% formed by quantity and quality of potatoes crop. The study revealed that the main *sources of information about market prices* were distributed as 74.3% for wholesalers, while 17.1% and 8.6%% allocated for retailers and brokers respectively. The study found that the *retailers intend to sell potatoes in markets* mainly for consumers by about 88.6%, while 11.4% of them go to the other wholesalers. Finally, the *determination of potatoes selling prices* according to the retailers reports were found as 51.4% determined by marketing prices forces and 48.6% according to quantity and quality of potatoes. This confirms that the marketing preference of actors in potatoes markets in the State is predominant.

Potatoes consumption in the State

Despite this humble tuber's popularity, shoppers have generally been offered very little choice about what types of potato to choose from. Supermarkets and some farmers' markets are increasing their range of old and new potato varieties, with myriad tastes and textures. Whichever you buy, they should be firm and well-shaped with no eyes or green patches. The British tend to prefer white-fleshed tattles, whereas the Dutch and Spanish like yellow-fleshed potatoes, but color makes little difference to the taste. Once cooked the texture of potatoes can range from smooth, waxy-textured flesh perfect for salads to floury-textured flesh ideal for fluffy mashed potato, so it's important to know what type of potato you've bought before you decide how to cook them. Consumers of potatoes mainly use potatoes for fast food or to be prepared as the chips and boiled for the kids. The study results appear that the majority of the consumers purchase potatoes from retailers in local markets. The research also considered *the important of the potatoes for you as the house keeper*, it shows that 73.5% of the consumers prefer prepared potatoes as fast food, while 26.5% of them reported potatoes crop important for starch benefits for the children. In other words, and based on consumers responds, the most preferred type of cooked potatoes, the study revealed that 55.9% of the consumers preferred to use the crop for different kind of food, while 23.5% as boiled potatoes and 20.6% preferred potatoes chips as

shown in figure 5. The research has considered *the frequencies of potatoes consumption*, it unveiled that 88.2% of the consumers purchase potatoes every week, while only, 5.9% of the consumers purchase potatoes every day and the percentage (5.9%) every two week indicating that the demand for potatoes high and increasing.



Sources: field survey, 2020

The study also aimed to *identify the relevant markets for consumers*, it revealed that 67.5% of consumers purchase potato usually from retailers in the local markets, and17.6% of them purchase potato from retailers in the central markets of the State, this mean consumers usually require small amount of the crop just mainly for household consumptions, while *consumers look to buy potatoes from a particular actors* where 70.6% of the consumers prefer to purchase potatoes from retailers in the local markets, while 20.6% of them prefer to purchase from retailers in central markets, and only 8.8% of the consumes prefer to purchase potato from shops cross the road. The *potatoes consumers justify their selection of the mentioned markets* due to some reasons, that 50.0% of the consumers prefer to purchase potatoes for its good quality, while 41.2% of the consumers prefer to purchase potatoes for its cheap price, and only 8.8% of the consumers prefer to purchase potatoes for its near place. The study also found that *the consumers look for good quality of potatoes with a certain criterion*. It reported that 67.6% of the consumers preferred potatoes based on the form and volume; while 26.5% of the consumers purchase potato according to the variety or type, and there are only 5.9% choose potato for purchase according to the price. *The consumers usually prefer fresh potatoes for consumption*. The results shows that 73.5% of the consumers don't used cold storages or freezer for saving their potatoes, while 26.5% of the consumers like to use cold storage or freezer for saving potatoes for a long time.

From Table 7 the distribution of consumers according to purchased quantities (kg) and prices (SDG), and also it shows the withdrawn quantity during a month per sack in River Nile State.

Table 7: Distribution of potatoes consumers according to purchased quantities and prices

Variable	Consumers	
	Mean	SD
Quantity (kg)	1.47	.873
Prices (SDG)	32.64	8.637

Sources: field survey, 2020

Table 8 summarizes and represents the average purchase prices, selling prices, costs, revenues, and profits for each stage of potatoes production as well as marketing stages among potatoes value chain in the River Nile State.

Table 8: Profits and marketing margins of one ton of potatoes for different actors

Items	Value (SDG/ton)
Producers:	
Purchase price of potatoes	7634.53
Production expenses	1450
Selling price of potatoes	12000
Gross marketing margin (GMM)	4365.47
Gross profit margin (GPM)	4365.471
Cold storage owner:	
Purchase price of potatoes	12000
Operation expenses	260.9
Selling price of potatoes	19000
Gross marketing margin (GMM)	7000
Gross profit margin (GPM)	6375
Wholesalers:	
Purchase price of potatoes	19000
Marketing expenses	398.06
Selling price of potatoes	22894.6
Gross marketing margin (GMM)	3894.6
Gross profit margin (GPM)	3496.54
Retailers:	
Purchase price of potatoes	23028.4
Marketing expenses	791.5
Selling price of potatoes	30570
Gross marketing margin (GMM)	7541.6
Gross profit margin (GPM)	6750.09

Source: Field survey, 2020

From the table it was noticed that the retailers achieved the highest gross marketing margin (GMM) and gross profit margin (GPM) as SDG 7541.6 and SDG 6750.09 respectively, ranked by cold storage owner for one ton potatoes marketing, while the wholesalers were formed the lowest percentages. On the other hand, the producers recorded the highest cost of production for the crop appeared as SDG 1450 compared to potatoes actors of the crop value chain.

Conclusion and policy implication

The main outcomes of this research comprise increased potatoes production, improved potatoes quality, institutional and human capacity building, higher standard of living of potatoes growers, and advanced role of potatoes in contributing to increase the national revenue from sales of potatoes locally and abroad. Several points represented at the conclusion and policy implication part as follow:

1. Potatoes producers should develop awareness:

a. Cultural practices suitable to different agro-ecological zones, irrigation supply, pesticides and fertilizers use, and frequent water and soil analysis and the importance of crop rotation.

b. Appropriate management practices for the control of major pest and diseases in the existing groves and for the protection of new ones.

c. Provision of facilities for training technician, extension agents and growers' proper pre-and harvest technologies for potatoes production and marketing. Interventions concerning the crop growers should aim to raise their awareness how to think as if as small entrepreneur

d. Promotion of techniques for the post-harvest handling, processing and making of potatoes and for utilization of by-products.

e. Identification of superior varieties with emphasis on adoption to non-conventional growing areas and high quality varieties for local consumption as well as exportation.

f. Encouragement of expansion of potatoes growing at potential areas in the State and by supplying the private sector with suitable planting material and recommendations on appropriate cultural practices.

g. Importance of working to gather in small groups or cooperative associations in order to reduce share and minimize costs of production (using proper methods of calculating production costs and keeping records and other basic business management), distribution and marketing, protect each other from marketing instability through share of experiences and strengthen the bargaining power within the chain.

h. Different available options regarding access and process to agricultural finance.

2. Potatoes retailers, wholesalers, and cold storage owners should develop awareness:

a. Distribution and transportation of the crop, marketing and exhibiting at trade fairs.

b. The potential of investing in storage facilities of potatoes (cold storages and cold trucks)

c. Correct and feasible selection for new markets.

d. Global standards of international trade and methods of adopting them, and fair trade and ethical trading principles.

3. Governmental institutions should:

a. Play a role in providing financial support to the crop growers to gradually break the tight grip of traders and wholesalers over the whole value chain.

b. Encourage greater facilitation by financial institutions for businesses to access finance

c. Enforce implementation of an agriculture calendar maximize production, reduce risk, and competitiveness is increased through forming a steering committee with core members who are active key players from the whole value chain.

d. Establishment of a training center for specialized institutional and human capacity building. To learn them step by step about the way of how to increase the crop yield per unit area.

f. Improvement of techniques for genetics, breeding and propagation (i.e. Potatoes breeding research is required for evolving new varieties which give high yield and should have resistant against disease and pest attacks). The main service provider for this part in Sudan is Agricultural Research Corporation (ARC), the flowing part is concerning with this important institution in the country.

Potatoes research in Sudan is managed mainly by Agricultural Research Corporation; it addresses a number of issues anticipated to develop the crop sub-sector, such as follow:

1) Sustainable potatoes production techniques, potential cropping systems and appropriate plant genetic resources explored, identified and conserved in various regions of Sudan in accordance with the comparative advantage and food security requirements.

2) Strengthened national capacity in protection and prevention of potatoes pests and diseases; and
3) Developed potatoes' agricultural research processes, systems and programs.

The key expected results will be achieved through several interventions as follows:

a) Assess and evaluate the present situation of potatoes diversity and production.
b) Review the agro-climatic data of the areas and agricultural resources availability for sustainability of potatoes cultivation.
c) Review and assess the current potatoes research strategies and propose key interventions to enhance development of efficient agricultural practices techniques.
d) Explore the potential areas for cultivation of potatoes in River Nile State and hence at the macro levels.
e) Assess the local potatoes selections and develop standard protocol for identification and regional comparative advantage.
f) Identify key technical production constraints to be overcome.
g) Identify harvest, post-harvest and marketing constraints and develop improved techniques and channels.
h) Identify needs of international technical assistance to support the development of potatoes industry.
i) Assess the local technical support capacity for potatoes development and identify the necessary components of a comprehensive training program aims at providing the technical staff and the stakeholders with the required knowledge.
j) Identify the investments in terms of manpower, equipment, internal and external training that would be required to overcome the technical constraints faced by the relevant regions as related to development of the potatoes industry.

References

Abdel Magid, H.M. (1991) Productivity of wheat and alfalfa under intercropping. Exp. Agr. 27, 391–395.

Abdallah S, Fan I (2012) Framework for e-government assessment in developing countries: Case study from Sudan. Electronic Government, an International Journal 92: 158-177.

Singh, N.P., Hardway A. K., Kumer A. and Singh, K.M. (2004). Modern technology on vegetables production. International Book Distributing Company, India.

FAO (2012). Food and Agriculture Organization of the United Nations, FAOSTAT database 2015.

Ministry of Agriculture and Animal Wealth and Irrigation of Khartoum State: Field Administration reports (2000-2007), General Administration of Agriculture Services.

Haddad, M. (2002). Potato production and marketing in Khartoum state. MSc. thesis, Faculty of Agriculture, University of Khartoum, Sudan.