

## Impact Analysis of Government Policies on the Economic Performance of Some Horticultural Crops in the Sudan (2009-2013)

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### Abstract

The earnings from horticultural exports in Sudan were very weak. They constituted only 0.4% of the total Sudanese exports earnings. The main objective of this study was to analyze the impact of Government policies on the performance of selected horticultural crops during the period 2009-2013 in terms of efficiency, competitiveness and comparative advantages. The study depended on secondary data and information collected from the annual reports of the Federal Ministry of Agriculture. The policy analysis matrix (PAM) adopted as an analytical tool to achieve the study objectives. Parameters have been estimated for onion, melon, banana and mango. Private profitability, social profitability, nominal protection coefficient of outputs, nominal protection coefficient of inputs, effective protection coefficient, domestic resources coefficient, profitability coefficient, and subsidy ratio to producer were calculated for the crops under consideration. The study results showed that the nominal protection coefficient of inputs (NPIs) was less than one which indicated that the adopted policy encouraged the production. The nominal protection coefficient of outputs (NPCs) was greater than one for onion, banana and mango with the exception of melon, whose NPC about 0.62. This indicated that the government policies provided incentives and favored the production of vegetables and fruits. The effective protection coefficient (EPCs) was greater than one. The domestic resources coefficient (DRC) was less than one which indicated that there are still comparative advantage of the production of vegetables and fruits in Sudan. The study recommended further vertical and horizontal expansion of vegetables and fruits production, and furthermore distorting policies may be revised and input taxes have to be reduced.

**Keywords:** Horticultural crops; Policy analysis matrix; Economic performance; Sudan

### Background

The agricultural sector of Sudan represents the most important sector of the economy. The available information show that it contributed about 35-45% of the country's GDP during the period 1970-2011. Also, it accommodates about 57% of the workforce and it provides most of the inputs for the manufacturing industries such as oil, sugar, and textile, while it is considered the main pillar for sustainable development and food security.

After the separation of South Sudan, the area of Sudan is estimated to about 4,446 million feddans. In terms of kilo meters, Sudan is classified as one of the largest countries in Africa with a total area at 1.882.000 km<sup>2</sup>. The main activity of its population is agriculture. The total area of the agricultural land in Sudan amounts to approximately 200 million feddans. The area under cultivation is about 40 million feddans or some 20% of the total arable area for agricultural production. Agriculture as an economic activity is practiced almost everywhere in Sudan, where we can distinguish three agricultural systems. These include traditional and mechanized rain fed agriculture in addition to irrigated agriculture. However, while irrigated agriculture is concentrated at the banks of the Nile River and its tributaries and the area between the Blue and white Niles (the part of the area defined as the plains flood which is characterized by high productivity and fertility). This is known to be a land which is suitable for the cultivation of all kinds of cotton, groundnuts, wheat, sugar cane, vegetables, legumes, spices and all kinds of fruits. The traditional and mechanized rain fed agriculture is found in Gedarif area, Blue Nile and White Nile areas, in addition to greater Kordofan and Darfur regions. In addition, the Sudanese agricultural sector includes the livestock sub-sector, the fishery sub-sector and the forestry and wildlife sub-sector [1]. Moreover, Sudan enjoys diversified climates and geographic locations that encourage the production of various agricultural crops including grain and pulses, fiber and

horticultural products, in addition to a wide range of livestock, forestry and fishery products.

The irrigated and mechanized rain fed sub-sectors provides about 80% of the principal food cereal and oilseed crops, and about 50% of export earnings. The importance of the traditional rain fed agriculture, the livestock sub-sector, the pastures and forestry subsector rests not only in their contribution to crop output only but also in providing the livelihood for about 90% of the agricultural population, who represent 65% of the total population.

The major crops produced within the traditional and mechanized rain fed agricultural sub-sector are sorghum, sesame and millet, in addition to rain-fed cotton. However, the irrigated sub-sector's major crops are cotton wheat and sorghum, in addition to groundnuts, pulses crop and the whole range of horticultural crops.

The cultivation of the horticultural crops is practiced along the banks of the River Nile and the banks of the White and Blue Niles and their tributaries, as well as under surface irrigation within the major irrigation schemes or in fields irrigated by pumps from wells. However, the acreage and output and yields, as well as the exported volume and export receipts of the produced horticultural crops is relatively small as compared to that of the other groups of crops e.g., cereals, fiber crops

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and oil seed crops. This is, however, so despite the fact that the Sudan possesses ample opportunities for a huge production of horticultural crops and, hence, an increased contribution of their export earning to the national economy. Thus, the Sudanese horticultural sub-sector has never been in the position to utilize the available opportunities for an increased crop output and expanding export earnings [2].

The reasons underlying the above mentioned fact are multifaceted. They include reasons pertaining to the adopted technologies as well as reasons of economic nature such as marketing and export, financing and adopted policies.

Based on the above mentioned facts, the performance of the Sudanese horticultural export has persistently been weak since the evolution of horticultural export. It amounted during (1993-2014) an average of about \$ 4.5 million and 0.4% of total Sudanese exports. The total area under the horticultural products amounted to about 0.8 million feddans in 1997 [3]. This area represents only about 2% of the total area under the agricultural cultivation, which is equal to about 38.2 million feddans during the same year and about 0.4% of the total arable area. Regarding the total output of the same period, the Sudanese horticultural sub-sector produces about 5 million tons or 44% of the total agricultural production, which was estimated at 11.3 million tons [4].

### Statement of the problem

As already mentioned, the Sudan possesses huge opportunities for the production and export of horticultural crops. These include abundant land resources, fertile soils, and adequate irrigation water, in addition to the diversified climatic regions that provide for an expanded and efficient production of horticultural products. In addition, the Sudan, especially, most of the horticultural production centers that have comparative advantage for various horticultural crops lie in close vicinity to certain promising demand markets for horticultural products. Moreover, the Sudanese authorities concerned with the issues of horticultural production and export at the various levels of the government followed during the past decades a policy track that encourages the production and export of horticultural products. Similarly, the government overall wide economy, as well as sector specific economic policies, has been in favor of production and export of horticultural crops. These policies went further to the extent that they encouraged the establishment of training and research institutions, in addition to other related institutions like those involved in sorting, packing, processing and marketing to facilitate the production and export of horticultural crops. However, despite all these opportunities, the production and export of horticultural products remained extremely weak. The reasons for this weakness are multifaceted. They include production difficulties as well as marketing and export problems, in addition to policy related problems.

The reasons for this weakness are multifaceted. They include production difficulties as well as marketing and export problems in addition to policy related problems. However, this study focuses on the policy problem of the horticultural export products. Prompted by the above mentioned fact, many researchers engaged in studying the reasons for the weak performance of the horticultural sub-sector. This study, however, attempts to examine the government adopted policies within the sphere of horticultural exports.

### Objectives of the study

The main objectives of this research include the assessment of the opportunities for an expanded horticultural production and exports, in addition to the examination of the adopted economic policies,

which were implemented to expand the production and exports of the horticultural products. The specific objectives of the study encompass the following:

1. Assessing the productive capacities for an expanded horticultural production.
2. Examination of the capacity of the potential demand markets for horticultural products from Sudan.
3. Assessment of the impact of the adopted government policies on output, producers and resources use.

### Research questions

The research questions set to this study rotate around the policy incentives and crop competitiveness provided by the government agricultural policy, which was adopted during the period analyzed in this study. On this basis, the research questions to be answered by this study include the following:

1. Do the adopted government's policies encourage the export of the export crops focused in this research?
2. What is the magnitude of the coefficients of price and output incentives provided by the adopted government policies towards the export crops focused in this research?
3. Do the adopted government policies encourage the competitiveness of the export crops focused in this research?
4. What is the magnitude of the coefficients of competitiveness provided by the adopted government policy towards the export crops focused in this research?

### Organization of the research

The study consists of five chapters. Chapter one is an introductory chapter and it includes a background, statement of the problem, objectives of the study and the research methodology, in addition to the research questions and organization of the thesis.

Chapter two provides a comprehensive review of the Sudanese horticultural sub-sector. Chapter three describes the research methodology and provides the theoretical background of the undertaken research.

Chapter four presented the conceptual framework underlying the undertaken analysis, in addition to a description of the employed analytical technique.

Chapter five presented the obtained results of the conducted analysis, their interpretation and an attempt to an explanation of the results, in addition to the conclusion of the results, their implications and the recommendations drawn from the results and from their implications. Finally, chapter six provides a summary of the study.

## The Horticulture Subsector in Sudan

### Background

The Sudanese horticultural sub sector comprises two branches, namely, the vegetable and fruit sub systems. Most of the production units within the horticultural sub sector, especially those for fruit production, lie along the banks of the river Nile and its tributaries. However, the irrigated schemes occupy increasing areas for vegetable production. The majority of the crops within these sub systems are produced under irrigation by private producers, in addition to some

horticultural output produced under rain fed conditions in south Kordufan, Darfur and Blue Nile states. The size of the holdings within the horticultural sub sector that lie along the banks of the Nile system ranges between 1-50 feddans, while the size of the horticultural holdings within the irrigated schemes ranges between 5-20 feddans. Moreover, few large-scale vegetables production units of over 2000 feddans were established by the national and multinational companies, such as the Arab authority for agricultural development and investment [5]. The importance of the horticultural sub-sector rests on a number of elements including the volume and value of the cultivated products, in addition to their economic impact on the economy and the welfare of the producers' and the labours and other stake holders involved in the sub-sectors activities, as well as, their nutritional effects on the population. The cultivated crops within the horticultural subsector include a wide range of vegetables and fruits. These crops are cultivated in different climatic zones with varying soil characteristics and varying levels of water availability. Similarly, the employed cultivation practices and production technologies are varying from climatic one zone to the other, while the intensity of cultivation of the various crops in each zone is dependent on the comparative advantage available for each crop.

### The major cultivated horticultural crops

As it is already known the horticultural crops are divided into the vegetables and fruits crops, in addition to other groups of crops including the floricultural crops, the medicinal crops and the spices crops. However, in this study, the major focus of the research is on the vegetables and fruit crops.

The major vegetable crops, which are cultivated in many places in Sudan, include Tomato, Sweet melon, Green beans and Sweet melon, in addition to Eggplant, Onion, Okra and potato, as well as cucumber. These vegetable are cultivated almost everywhere in Sudan as it is presented in Table 1. However, the most important regions for vegetable production in Sudan are Khartoum State, Gezira State, Northern and River Nile states, in addition to Kassala, Blue Nile and White Nile states. Nevertheless, there are other regions where vegetable cultivation is also practiced to a lesser extent than the aforementioned states like the states of Kordofan region and the states of Darfur region. The vegetables that are focused in this study are onion and melon. As already mentioned, these crops are selected because of their promising future as export crops. Although both of onion and melon are produced almost everywhere in Sudan, they are produced in an intensive manner in the River Nile State, Khartoum State, Kassala state and Gezira State. Based on the importance of onion and melon as promising export crops vegetable crops, the following sections of this study will focus on them.

The major fruit crops, which are cultivated in many places in Sudan, include Mango, Banana, Grape fruits, Orange and Lime, in

| Crop         | Production regions (states)   | Season    |
|--------------|---|-----------|
| Tomato       | Khartoum, Northern, River Nile White Nile, Blue Nile, Gezira, Kassala |           |
| Sweet melon  | Khartoum, Northern, River Nile, White Nile.                           | Dec-Mar   |
| Green beans  | Khartoum, Northern, River Nile  | Dec-Mar   |
| Sweet pepper | Khartoum, Northern, River Nile  | Oct-April |
| Eggplant     | Khartoum, Northern, River Nile, Gezira                                | May-June  |
| Okra         | Khartoum, Northern, River Nile, White Nile, Sennar.                   | Sept-June |
| Onion        | Khartoum, Northern, River Nile, Sennar, Kassala.                      | Nov-June  |
| Potato       | Khartoum, Northern, River Nile, Sennar, Darfur.                       | Potato    |

Table 1: The major cultivated vegetable crops and their production centers, 2015, Sudan [3,5].

addition to date. These fruit are cultivated almost everywhere in Sudan as it is presented in Table 2. However, the most important regions for fruit production in Sudan are Khartoum State, Gezira State, Northern and River Nile states, in addition to Kassala, Blue Nile and Sennar States. The fruits which are subjected to study in this research are mango and banana. The selection of these fruits is based under their importance and their promising future as export crops. Also, based on this importance the following sections of this study will focus on these two important fruit crops (mango and banana), in addition to the two important vegetable crops (onion and melon).

### The development of areas, outputs and yields of the cultivated horticultural crops

**The development of areas:** Table 3 presents the development of the areas of the two selected vegetables crops (Onion and melon) and the two selected fruits crops (mango and banana) during the period 2005-2014. As it can be seen, it appears that the area of onion has increased markedly from about 86 thousand feddans in 2005 to reach about 197 thousand feddans in 2014. Accordingly, the area of onion has more than doubled during the period under consideration. The area of melon, the second vegetable crop under consideration, has increased very slightly to reach 10.4 thousand feddans in 2014 as compared to about 8 feddans in 2007.

As regards the areas of the two selected fruit crops under consideration, the area of mango increased similar to the area of melon very slightly from about 67 thousand feddans in 2005 to reach about 72 thousand feddans in 2014 (Figure 1). However, the area of banana increased also markedly similar to onion area to reach 81 thousand feddans compared to about 42 thousand feddans in 2005. Also, it could be said here that the area of banana has doubled during the period under study.

**The development of outputs:** Table 4 presents the development of output of onion, melon, mango and banana during the period 2005

| Crops       | Producing states  | Season                  |
|-------------|---|-------------------------|
| Mango       | Khartoum, Kassala, River Nile, Sennar, Darfur, Gezira, Kordofan, Blue Nile. | Dec-Sept                |
| Banana      | Kassala, River Nile, Sennar, Khartoum, Blue Nile.                           | All the year            |
| Grapefruits | Khartoum, Kassala, River Nile, Northern, Gezira.                            | Nov -March<br>July-Sept |
| Orange      | River Nile, Kassala, Khartoum, Blue Nile, Sennar, Darfur.                   | All the year            |
| Lime        | All over the country.   | All the year            |

Table 2: The major cultivated fruits and their production centers, 2015, Sudan [1].

| Year    | Crops area (000) fed. |                |       |        |
|---------|-----------------------|----------------|-------|--------|
|         | Onion                 | Melon (Gallia) | Mango | Banana |
| 2005    | 86                    | n.a            | 67.3  | 42.8   |
| 2006    | 86                    | n.a            | 67.8  | 43     |
| 2007    | n.a                   | 8              | 68.6  | 45     |
| 2008    | n.a                   | 8.2            | 69.8  | 47.4   |
| 2009    | 128                   | 9              | 71.3  | 52     |
| 2010    | 139.5                 | 9.2            | 69.4  | 57     |
| 2011    | 152                   | 9.5            | 70    | 62.5   |
| 2012    | 165.6                 | 9.8            | 70.6  | 68.5   |
| 2013    | 180.4                 | 10.1           | 71.2  | 75     |
| 2014    | 196.5                 | 10.4           | 71.5  | 81     |
| Average | 141.7                 | 9.27           | 69.7  | 57.4   |

Table 3: The development of areas of onion, melon, mango and banana, 2005-2014, Sudan [1].

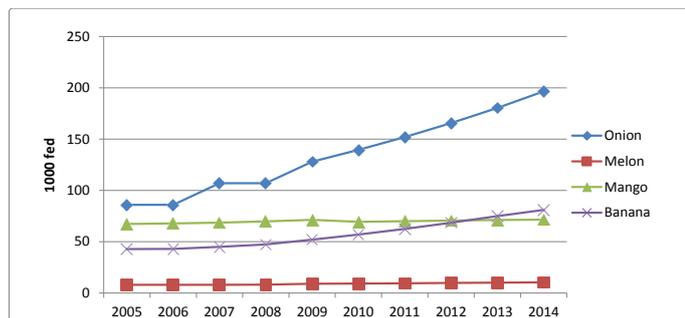


Figure 1: The development of areas of onion, melon, mango and banana, 2005-2014, Sudan.

| Year    | Crop output (000) ton. |        |       |        |
|---------|------------------------|--------|-------|--------|
|         | Onion                  | Gallia | Mango | Banana |
| 2005    | 59                     | n.a    | 605   | 512    |
| 2006    | 59                     | n.a    | 611   | 516    |
| 2007    | n.a                    | 23     | 632   | 254    |
| 2008    | n.a                    | 24     | 651   | 562    |
| 2009    | 1024                   | 25     | 616   | 624    |
| 2010    | 1116                   | 27.6   | 625   | 684    |
| 2011    | 1136                   | 24     | 630   | 750    |
| 2012    | 1325                   | 4.29   | 635.4 | 822    |
| 2013    | 1443.2                 | 30.3   | 641   | 900    |
| 2014    | 1575                   | 31.2   | 650   | 980    |
| Average | 967.1                  | 23.6   | 630   | 660.4  |

Table 4: The development of outputs of onion, melon, mango and banana, 2005-2014, Sudan [1].

-2014. The output of onion and banana shows a marked increase, while the output of melon and banana has increased only slightly.

As it can be seen from Figures 2 and 3, the highest increase in output of the studied crops was recorded by onion, thus, its output increased steadily from less than 100 thousand tons in 2005 to reach more than 1.5 million tons in 2014. Also, the increase in output of banana appears to be marked. It increased from some more than 500 thousand tons in 2005 to reach about one million tons in 2014.

The increase in output of onion and banana could be explained the expansion of cultivated areas of the two crops, in addition to the use of improved technology in production of the two crops, especially, the use of improved seed varieties of onion and improved seedlings of banana.

As regards melon (Gallia) and mango, the only slight increase in their output could be explained by negligible expansion in their cultivated areas.

**The development of yields:** Contrary to the development areas and outputs of the crops under study, the development of their yields during the analyzed period appears to be negligible (Table 5). Thus, the yield of onion increased very slightly, while that of melon, mango and banana remained almost constant, despite the increased use of improved seed and seedling varieties of these crops during the period under analysis. However, this result might be attributed to the poor practiced cultural practices.

### The consumption of horticultural crops in Sudan

Unfortunately, there is no reliable and published data about the consumption of horticultural crops in Sudan. However, the aforementioned expansion in the cultivated areas, out puts, and yields

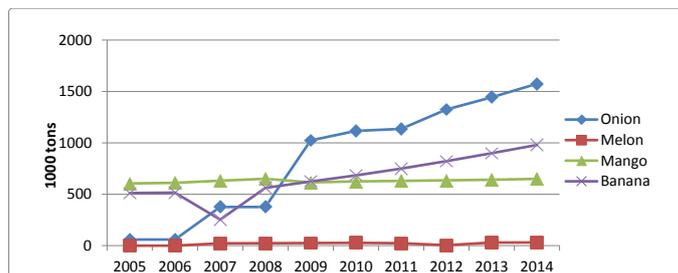


Figure 2: The development of outputs of onion, melon, mango and banana, 2005- 2014, Sudan.

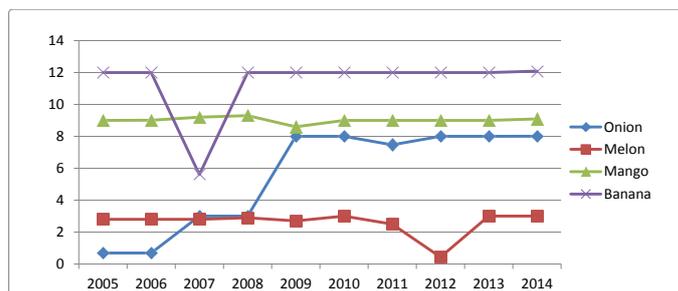


Figure 3: The development of yields of onion, melon, mango and banana, 2005-2014, Sudan.

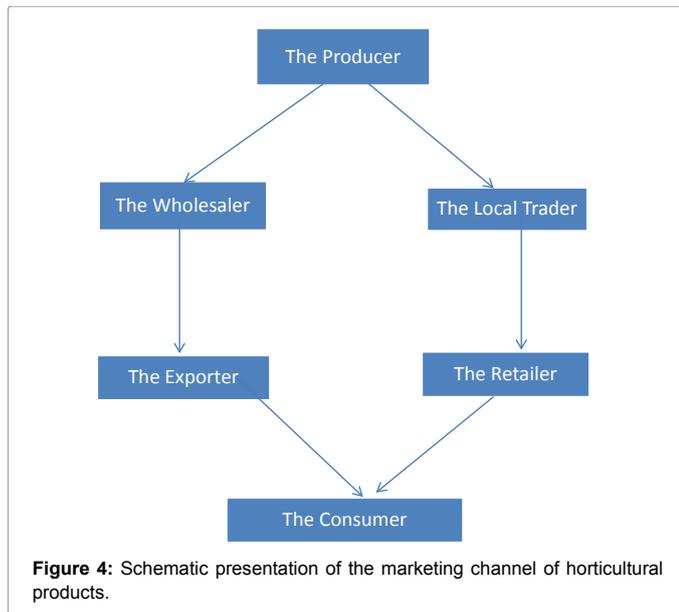
| Year    | Crops yield (000) ton |        |       |        |
|---------|-----------------------|--------|-------|--------|
|         | Onion                 | Gallia | Mango | Banana |
| 2005    | 0.69                  | n.a    | 9     | 12     |
| 2006    | 0.69                  | n.a    | 9.01  | 12     |
| 2007    | n.a                   | 2.8    | 9.2   | 5.6    |
| 2008    | n.a                   | 2.9    | 9.3   | 12     |
| 2009    | 8                     | 2.7    | 8.6   | 12     |
| 2010    | 8                     | 3      | 9     | 12     |
| 2011    | 7.47                  | 2.5    | 9     | 12     |
| 2012    | 8                     | 0.43   | 9     | 12     |
| 2013    | 8                     | 3      | 9     | 12     |
| 2014    | 8.01                  | 3      | 9.09  | 12.09  |
| Average | 5                     | 2.03   | 9.02  | 11.4   |

Table 5: The development of yield of onion, melon, mango and banana, 2005-2014, Sudan.

of the different horticultural products, coupled with the improvement in increasing awareness about the importance of fruits and vegetables in human nutrition, signifies that the per capita consumption of horticultural crops has increased. Nevertheless, it is expected that the increase in consumption of horticultural crops is more pronounced in the urban centers in comparison to the rural areas.

### The marketing of horticultural crops in Sudan

The marketing of the different varieties of the horticultural crops produced in the different areas of Sudan takes place according to the marketing channel depicted in Figure 4. As it can be seen, these products are marketed in a rather simple way. Thus, most of the horticultural crops, which are destined for local consumption or for export, are directly transported from the farms by the producers to the nearest central market within the area of production. The produces are then sold to the wholesalers, who distribute it to the retailers in the different locations in the towns. However, the vegetables and fruits destined for export are washed and packed in private centers for



preparation of horticultural export and transported through Khartoum airport or Port Sudan harbor to the different demand markets in Saudi Arabia or the Gulf countries.

### The export of horticultural crops

The importance of the Sudanese horticultural exports contribution in the national economy may be due to many factors. An essential one of them may be its role to diversify and expand the Sudanese agricultural exports, hence to contribute in overcoming the risks of depending on a few numbers of agricultural exports. In addition, the horticultural exports might be an important source of foreign exchange, expansion of farmers' income and a mean of provision of various jobs. However, despite the anticipated prospects for the successful horticultural export industry in Sudan, the realized output of horticultural exports is relatively small, as compared with the Sudanese horticultural Production and prospects, as well as with the available Arab and EU import. Thus, the yearly total Sudanese horticultural exports averaged during 1989-2009 at about 7.2 thousand tons or 0.2% of the total horticultural production, while the average value of the horticultural crops of Sudan during the period 1993-2009 was estimated at about \$2.3 million, which represents about 0.4% of the total value of Sudanese exports during the same period (Table 6).

### The exported crops

The available literature signifies a great potential for the Sudanese horticultural exports. This potential rests not only on the promising demand for these crops in the different importing markets in the Arab world and the European Union but also on the tremendous potential production of these crops in the Sudan.

However, despite the difficulties facing the development of the Sudanese horticultural exports and its sluggish performance, the export mixture of the Sudanese horticultural exports encompasses a wide range of fruits and vegetables products. Thus, the active Sudanese export institutions used to export a variety of fruits including mango, grape fruits and lemon, in addition to banana and dates. As regards the exported vegetables, their export mixture includes green beans, melon and Gallia, in addition to okra.

### The exporting institutions

The horticultural export middlemen classification is based on many factors, including the institutions ownership nature (private or public), the business experience age, the organization extent and capacity, their capital size, the personnel qualification (traditional or modern), the providence of modern technological equipment's (on their ownership or on rent basis), the degree of specialization in exporting one or more crops. However, the performed role by these middlemen can be only assessed in categorizations, descriptions and estimations, because of the often limited and sometimes absent of available necessary data for a systematic analysis about these institutions and their performance.

**Private export institutions:** This category of horticultural export institutions comprises wide range of traditional private exporters, who can be classified as traders, in addition to modern small scale companies which are be belonged to single or many holders.

**Traditional private exporters (traders):** Those traders are working on traditional basis. Most of them are working individually within their limit available private capital. However, some of them are specialized in one horticultural export, while, others engaged in exporting a group of horticultural and other agricultural crops.

The important features that are differentiating between these middlemen and the modern private small-scale companies include, that they are organized on traditional basis, the absence of trained personnel and the major lack of export infrastructure, like; equipped post-harvest operations. Hence, the majority of them carry out their business activities on rent basis.

**Modern private small-scale companies:** The modern private small-scale companies are another type of the private horticultural exporters. They are similar to private traders' institutions in that some of them are specialized in one horticultural product, while; others are engaged in exporting a group of horticultural and agricultural crops. In addition, they are similar to them in that they lacked the required export infrastructure like sorting, grading, packaging, packing, transportation and storage facilities. However, the private traders and the small-scale modern companies are differed from each other in many aspects. Hence, the modern companies are organized on modern basis and they are to some extent equipped with trained personnel who can access the international markets. Similarly, the small-scale modern export institutions depend, as the private traders, on other export institutions to carry out their business activities on rent basis. Moreover, their dependency on other companies is only limited on such a provision of export post-harvest services. While, the companies are in a position of arranging the products transport to target the international markets and conducting other export activities like delivering the product, negotiating its prices, and receipt the value.

**Public companies:** The public companies include two types of export institutions; the first one is the public affiliate companies that organized to work on private basis such as the Sudanese horticultural export company (SHEC). While, the second type which is engaging in horticultural exports, can be represented by the joint venture, like the Sudanese Arab company for the agricultural investment (SACAI).

**Public affiliate company:** This type of public export institutions is represented by the Sudanese horticultural export company (SHEC), which is organized to work on private basis. The SHEC is established in early 1990's with the major objective to promote the export of horticultural products. The company is endowed with the required personnel and equipment to carry out the export activities for traders or

| Years   | Export value (\$ million) |       |           |        |          | Share in total value % |       |           |
|---------|---------------------------|-------|-----------|--------|----------|------------------------|-------|-----------|
|         | Agric.                    | Hort. | Petroleum | Others | Total    | Agric.                 | Hort. | Petroleum |
| 1993    | 349                       | 1.1   | 0         | 78     | 417      | 84                     | 0.3   | 0         |
| 1994    | 386                       | 2.6   | 0         | 138    | 524      | 74                     | 0.5   | 0         |
| 1995    | 446                       | 4.4   | 0         | 110    | 556      | 80                     | 0.8   | 0         |
| 1996    | 478                       | 3.5   | 0         | 142    | 620      | 77                     | 0.6   | 0         |
| 1997    | 425                       | 2.6   | 0         | 169    | 594      | 71                     | 0.7   | 0         |
| 1998    | 467                       | 3.6   | 0         | 129    | 596      | 74                     | 0.6   | 0         |
| 1999    | 404                       | 2.1   | 276       | 100    | 780      | 52                     | 0.3   | 35        |
| 2000    | 365                       | 10.1  | 1249      | 193    | 1807     | 20                     | 0.7   | 75        |
| 2001    | 236                       | 2.3   | 1277      | 183    | 1699     | 14                     | 0.1   | 81        |
| 2002    | 339                       | 2.5   | 1511      | 99     | 1949     | 18                     | 0.1   | 78        |
| 2003    | 381                       | 2.1   | 2048      | 113    | 2542     | 15                     | 0.8   | 80        |
| 2004    | 338                       | n.a   | 2100      | 339    | 2777     | 14                     | 0.3   | 82        |
| 2005    | 379                       | n.a   | 4187      | 260    | 4824     | 9                      | n.a   | 87        |
| 2006    | 359                       | 1.1   | 5087      | 211    | 5657     | 8                      | 0.02  | 90        |
| 2007    | 350                       | 0.6   | 8419      | 110    | 8879     | 4                      | 0.9   | 95        |
| 2008    | 373                       | 0.3   | 11094     | 203    | 11670    | 3                      | 0.2   | 95        |
| 2009    | 315                       | 1.5   | 7131      | 388    | 7834     | 5                      | 0.02  | 91        |
| 2010    | 117.89                    | 2.14  | 94,06,036 | 252,60 | 10716.88 | 1.1                    | 0.01  | 87.7      |
| 2011    | 3571.59                   | 2.33  | 70,03,502 | 97,472 | 95986.01 | 3.7                    | 0.002 | 7.2       |
| 2012    | 645.53                    | 39.1  | 6,98,842  | 116,98 | 3367.66  | 19                     | 1.2   | 21        |
| 2013    | 3614.38                   | 4.83  | 39,10,565 | 375,23 | 7086.22  | 51                     | 0.07  | 55        |
| 2014    | 986.81                    | 2.23  | 1,090.79  | 255.53 | 4350.2   | 23                     | 0.05  | 25        |
| Average | 697                       | 4.5   | 957473    | 4577   | 7569     | 33                     | 0.4   | 53        |

Table 6: Value and share of the Sudanese horticultural exports, 1993-2014 [6,7].

exporters, who lacked the facilities to access the international markets and undertaking the required export services. The company engaged in many activities, like production, marketing and export to promote the Sudanese horticultural exports. Thus, it provides the horticultural producers with various inputs like seeds, fertilizers, plant protection services and cash. Also, it conducts all the other fiscal and economic export activities on contract basis where the producers deliver the product, then it undertakes the marketing and export activity and finally subtracts its costs and commission and delivering the rest of the net value to the producers.

**Joint venture companies:** The joint venture is another type of public export institutions in Sudan, which is engaging in horticultural export. It is represented by the Sudanese Arab company for agricultural investment (SACAI). The company is established between the government of Sudan and the Arab authorities for agricultural investment. It is well equipped with modern export infrastructure and trained personnel to work on almost all types of agricultural and horticultural crops. It is divided into specialized branches in the various types of production, marketing and export fields. In addition to producing and exporting wide size of horticultural crops, the company is also engaging in providing export services for private exporters and companies on rent basis Organization for Agricultural Development.

## Research Methodology and Theoretical Background

### Research methodology

**The study area and the study subject:** This study focuses on the impact of the adopted government policy towards the Sudanese horticultural subsector. Accordingly, the study area of this research covers most of the central and northern parts of Sudan (the Northern State, the River Nile State, Khartoum, Gezira and White and Blue Nile States), in addition to Kassala State, where the crops under study are produced. However, while the export activities are concentrated in Khartoum, which represents the largest vegetable and fruit market in

Sudan, the focus of the study with respect to the marketing and export business activities is centered in Khartoum.

**The study subject:** As already mentioned, the Sudan possesses a huge potential to expand its horticultural exports. This is fact is based on the comparative advantages with which the Sudan is endowed, in addition to the promising demand markets for horticultural crops near Sudan (the Arab oil rich countries) and the globally expanding trend of horticultural trade. Moreover, the available statistics suggest that Sudan started to export a number of horticultural crops to the neighboring oil rich Arab countries since a number of decades. The number of these horticultural exports range between eight to ten products. However, as regards the study subject, the research focuses on four export crops; two vegetables (Onion and Melon) and two fruits (Mango and Banana). These crops are selected because of their importance as major export crops, in addition to the expected potential to expand their production and export volume and value.

**The data of the study:** This study employed inclusively secondary data. This data included data on the development of the acreage, production and yields of the studied crops. In addition, the employed data included farm records, as well as marketing data and data with regard to the export activities of the crops under study. The farm records included detailed cost of production of the crops under study, in addition to the farm gate prices of these crops. The crop marketing data included data on the detailed cost of marketing of the studied crops, while the data on the export activities of the crops under study included data on their international prices, transportation, handling and the charged export taxes and fees and other levies.

The sources of the above mentioned data are the records and publications of the federal and regional ministries of agriculture, the Custom Authority, in addition to the yearly books of the Bank of Sudan, Ministry of Finance and Economic Planning and the Arab Organization for Agricultural Development.

**The employed analytical methods:** This research employed the general statistical methods in presenting the trend of development of the historical data on the cultivated areas, production and yields of the studied crops. Also, the simple statistical methods were used to calculate and present the annual change in cropped areas, attained output and realized yields of the studied crops. In addition, the study used the established methodology of calculating the social prices of the studied crops and estimating the various coefficients of policy incentives. However, all of the aforementioned analytical exercises were conducted with the use of excel computer program.

### The theoretical background

**Agricultural policy:** Agricultural policy is a major instrument of Government intervention in the operation of agricultural markets. Government intervention in agricultural markets takes place to direct them to supply the surplus in food, industrial raw material and labour for industry, in addition to tax revenue and exports that earn foreign exchange [8]. Within this context, Governments have looked to agriculture to play a central role in the development process. In their efforts to stimulate growth, many developing countries overtaxed and underinvested in their agricultural sectors, guided by the theories that agricultural taxation would not significantly hurt agricultural production and that the surplus should be transferred to industry, the prime engine of growth.

The mechanism used to extract and transfer the agricultural surplus was price policy. The disincentives generated by unfavorable output prices were not reversed, however, by limited input price subsidies. Moreover, the macro environment and the trade regime further reinforced the bias against agriculture. In many countries problems in the agricultural sector spilled over into the rest of the economy and contributed to crises in industry, the trade balance, and the government budget. It became increasingly clear that a weak agriculture could not support a strong industry, and many governments had to reassess their entire development strategy.

Policy makers in attempting to design more effective agricultural policies can profoundly affect economic development. In developing countries agriculture is typically a large share of the domestic economy, and it contributes on average as much as 30 to 45 percent of growth domestic product (GDP). The percentage of the total labour force in agriculture is even higher [9].

Because agriculture is a major sector in most developing countries, governments use to realize their major objectives. These governments will continue to intervene extensively in the operation of agricultural markets, both directly through sector-level instruments and indirectly through macro and trade policies. Agricultural price policy strikes at the heart of the development process by altering relative prices facing individuals, households, and the sector as a whole. Because prices are both costs and income, individuals respond to them in their roles as producers, intermediaries, and consumers. Their responses to incentives induced by price policy inevitably shape the process of economic development and the distribution of incomes and welfares [10].

**Analysis of agricultural policies:** Analysis of agricultural policies can help policy makers to examine the consequences, intended and unintended, of specific policy changes on agricultural markets and assess the broader implications of these market-specific responses for the viability of the overall development strategy. Such analysis emphasizes the trade-offs between different objectives and different

measures, and policy makers can use this information to debate the pros and cons of alternatives.

The prices and markets selected for analysis can vary greatly depending on the questions and the resources available. Since agricultural price policy is an integral component of overall macro trade policy, a wide range of prices can be examined: macro (exchange rate and interest rate), trade (export and import), and sectoral (output and input). The analysis can be single market, multi-market, sectoral, inter-sectoral, or macro; partial or general equilibrium; static or dynamic.

### Conceptual Framework of the Model

#### The policy analysis matrix (PAM)

The policy analysis matrix method has been used as one of the modern tools to analyze the agricultural policies to derive some indicators and standard to measure the impact of the government agricultural policies on the agricultural sector. It has been initiated [11] to analyze market distortions and policy interventions in terms of their effect on the vertical system from its initial production in the farm through primary procurement, processing and marketing stages.

In this study, the PAM is used to analyze the impact of adopted government policies on the production of horticultural crops in order to derive comparative and protection indicators [12].

The PAM is a consistency framework which enables measurement of the efficiency effects of government policy intervention on producers, consumers and the economy at different stages of a vertical commodity chain. It can be used as a powerful tool by the policy analyst to provide information in two different ways:

- To measure the level of price distortion, government intervention and assess the effect of different policies.
- To compare the efficiency and growth potential of different farming, processing, and marketing systems for a given commodity and for different commodities.

**Policy analysis matrix structure:** The policy analysis matrix is a product of two accounting identities; one is defining profitability as the difference between revenues and costs and the other measuring the effects of divergences (distorting policies and market failures) as the difference between observed parameters that would exist if the divergences were removed [11]. By filling in the elements of the PAM for an agricultural system, an analyst could measure both the extent of transfers occasioned by the set of policies acting on the system and the inherent economic efficiency of the system.

Profit are defined as the difference between total (or per unit) sales revenues and costs of production. This definition generates the first identity of the accounting matrix. In the PAM, profitability is measured horizontally, across the columns of the matrix, as demonstrated in Table 7, profits, shown in the right hand columns, are found by the

| Revenues       | Cost           |                 | Profit |
|----------------|----------------|-----------------|--------|
|                | Tradable input | Domestic factor |        |
| Private prices | A              | B               | D      |
| Social prices  | E              | F               | H      |
| Divergences    | I              | J               | L      |

Whereas: A: Total revenue in private price (market prevailing price); B: Cost of tradable inputs in private price; C: Cost of domestic factors in private price; D: Private profit; E: Total revenues in social price (price which are adjusted for government intervention); F: Cost of tradable inputs in social prices; G: Cost of domestic factor in social prices; H: Social profits.

Table 7: The policy analysis matrix (PAM) structure [11].

subtraction of costs, given in the two middle column, are found by the subtraction in the left-hand column. Each of the column entries is thus a component of the profit identity revenues less costs equal profits [11]. Each PAM contains two cost columns, one for tradable inputs and the other for domestic factors. Intermediate inputs-including fertilizer, pesticides, purchased seeds, compound feeds, transportation, and fuel are divided into their tradable-inputs and domestic factor components.

This process of disaggregation of intermediate goods or services separates intermediate costs into four categories-tradable inputs, domestic factor, transfers (taxes and subsidies that are set aside in social evaluation), and non-tradable in put (which themselves have to be further disaggregated to do that ultimately all component costs are classified as tradable inputs, domestic factor, or transfers) [13].

As shown in the Table 7 Monke and Pearson arrange the data in three rows, the first row for the private price, the second row for social prices and the third row for the transfers, which the difference between private and social valuation of revenues, costs and profits. This difference is also referred to as the effect of government intervention or divergences.

The matrix is thus made up by the following identities:

Private or financial profit (PP):  $D=A-B-C$

Social profit (SP):  $H=E-F-G$

Output transfers (I):  $I=A-E$

Input transfers (J):  $J=B-F$

Factors transfers (K):  $K=C-G$

Total net policy effect (NPE):  $L=D-H=I-J-K$ .

**Social prices for tradable output and input:** Guidelines for the empirical estimation of the prices of tradable goods are identical for importable and exportable and for outputs and inputs. The private prices of tradable commodities (for the top row of the Policy Analysis Matrix) are found in farm budgets from actual market prices at the farm-gate. The counterpart social prices are border prices (comparable import prices for importable and export prices for exportable).

The social (or efficiency) prices of tradable commodities are given by comparable world prices because the import or export prices are the best measure of the social opportunity cost of the commodity. For additional unit to satisfy domestic demand, for an exportable, the export prices are a measure of the opportunity cost of an additional unit of domestic production since that would be exported, not consumed domestically. The world prices in domestic currency units is equal to the world prices in foreign currency time the foreign exchange rate (the conversion ratio given in domestic currency units to foreign exchange rate (the conversion ratio given in domestic currency time the foreign currency units). The calculation of social price of output begins with the (Free on Board) export price for exportable and (Cost Insurance Freight) import price for importable. These border prices are located at Port-Sudan. The sources of these prices are the annual reports of the Bank of Sudan.

The first step for deriving social outputs is the disaggregation of these inputs into domestic and foreign components by applying the standard percentages of foreign components of tradable determined by the Ministry of Finance and Economic Planning.

**Social prices of non-tradable:** As with tradable, the private prices for non-tradable (such as land, labour and capital) are taken

from the private budget at the farm-gate level. But no border prices access exists to serve as efficiency valuation for non-tradable. Hence, the social prices of non-tradable output are estimated by correcting their private prices for divergences (distorting policies and market failures). Sometimes it is very difficult to estimate the social prices for non-tradable commodities. The first step is to correct the private prices of non-tradable outputs for identifiable divergences. As noted above for tradable products, the researcher tried to adjust the observed private prices (A and B) for the effects of divergences (I and J) and thus find the social prices (E and F) as residuals. Often, however, the effects of divergences, especially of market failures and sometimes also of distorting policies especially of market failures and sometimes also of distorting policies, are nearly impossible to measure. If the effects of divergences cannot be estimated, the next step is search for the prices of a close substitute commodity to use as a proxy for the social prices of the non-tradable commodity. If that search fails, the last step is to seek the price of the same commodity [14].

The most common non-tradable goods and services include electricity, transportation, construction, labour and land. These can be both inputs and outputs to a project. Labour and land are primary factors of production and their economic evaluation must be treated separately to that of others. One way of carrying out the economic valuation of non-tradable goods is to break down the composition of each non-tradable good into traded and non-traded components until the stage is reached where the only non-traded components are labour and land.

**Labour:** Labour is a project input and like any other project input, it must be valued at its opportunity cost which might well different from its market value. This opportunity cost, or economic value of labour, is equivalent to the output foregone elsewhere in the economy as a result of employing that labour in the project. For economic project analysis, two broad categories of labour should be shadow priced.

**Unskilled labour:** Valuation of unskilled labour begins with an assessment of the degree of unemployment and/or underemployment of such labour. Where extensive unemployment and/or underemployment exist, the (practice adopted is to take a fraction of the current wage rate as the shadow price of unskilled labour. The arbitrary figure of 50% of current market wage rate or the minimum wage rate is often selected as an estimate of the opportunity cost of labour. The only underlying argument for the selection of this arbitrary figure is that for economic with high rates of underemployment the opportunity cost will generally is significantly less than the market wagger rate.

**Skilled labour:** Most instances skilled labour in developing countries is in short supply and would in all probability are fully employed without the project. As a result, wages paid to such personnel are generally taken as representing the true economic value to the society.

**Land:** In economic analysis, land is valued at its opportunity cost which is its net value of production foregone when the use of land is changed from its "without project use" to its "with project use" Ministry of Finance [7].

**Estimating the shadow exchange rate factor and standard conversion factor:** The shadow exchange rate (SER) is the economic price of foreign currency. There is a common misconception that if the market for foreign exchange is a free float, the shadow exchange rate (SER) is equal to the market exchange rate. That would be the case only if there were no taxes and subsidies on the demand and supply of tradable goods, if all commodities and factors were priced at their

economic value, and if the current account was sustainable. In all cases, the (SER) will diverge from the market or official exchange rate (OER).

Exchange rates are one of the key macro-prices affecting project performance. If the (OER) is taken as the (SER), and the (OER) is overvalued, then projects producing non-tradable with tradable inputs are favored relative to projects producing tradable with non-tradable inputs.

On the other hand, if the (OER) is undervalued, projects producing tradable with non-tradable inputs are favored relative to projects producing non-tradable with tradable inputs. In the event that the OER is depreciated to attain external competitiveness, or the OER is appreciated to attain internal competitiveness, project performance suffers. In general, the greater the divergence between the OER and the SER, the more likely will depreciation or appreciation occur and affect project performance.

Market prices are adjusted to economic values/prices using what are known as accounting prices, more commonly reflected to as shadow prices. Shadow prices are introduced to reflect the true economic cost of project inputs and output to the society in order to give emphasis to those projects which contribute to governments efforts to achieve national development objectives. Shadow prices of goods or services also known as National Economic Parameters, is thus a measure of the real worth to the economy of a specific project.

This method of shadow pricing is tedious and time consuming and consequently rarely followed. Instead, non-traded goods are generally valued at economic prices by the use of conversion factor. A conversion factor is a short-cut method for converting prices of non-traded goods and services into border prices. At the most aggregated level a single conversion factor, the standard conversion factor (SCF) is derived by taking the ratio of all exports and imports at the border prices to their value at domestic prices. Shadow prices of non-traded items are then obtained by multiplying the (SCF) with the market prices. This reduces market prices to their real economic value. The formula for the SCF is:

$$SCF = \frac{M + X}{(M + D) + (X - T)} \quad (1)$$

Where, M: Value of imports at border prices; X: Value of exports at border prices; D: Total import duties; T: Total export taxes.

This approach of converting the financial market value of non-traded goods and services to economic values is considered to be the weakest link in the logical chain of establishing shadow prices. Many applied studies therefore treat non-traded goods and services approximately [7].

Standard conversion factor (SCF) can be defined as the ratio of the economic price value of all goods in an economy at their border price equivalent values to their domestic market price value. It represents the extent to which border price equivalent values, in general, are lower than domestic market price values. The SCF will generally be less than one. For economic analysis using the world price numeracy, it is applied to all projects items valued at their domestic market price values to convert them to a border price equivalent value. While items valued at their border price equivalent value are left unadjusted. Conversion factors can be calculated and used when testing economic viability of a project. A conversion factor is the ratio between the economic price value and financial value for a project output or input. This ratio can be applied to the constant price financial values a project analysis to derive the corresponding economic values. Conversion factors can be calculated from [15].

**Private profitability:** The data entered the first row of Table 7 provide a measure of private profitability. The term private refers to observed revenues and cost reflecting actual market price received or paid by farmers, merchants, or processors in the agricultural system. The private, or actual, market price thus incorporates the underlying economic cost and valuations plus the effects of all policies and market failures. In Table 7, private profits, D, are the difference between revenues (A) and costs (B+C), and all four entries in the top row are measured the observed prices. The calculation begins with the construction of separate budgets for farming, marketing and processing. The components of these budgets are usually entered in PAM as local currency per physical unit, although the analysis can be carried out using a foreign currency per unit. The private profitability calculations show the competitiveness of the agricultural system, given current technologies, output values, input costs, and policy transfers. The cost of capital, defund as the pre-tax return that owners of capital require to maintain their investment in the system, is included in domestic costs (C), hence, profits (D) are excess profits above normal returns to operators of the activity [16]. If private profits are negative (D<0), operators are earning a subnormal rate of return and thus can be expected to exit from this activity unless something changes to increase profits to at least a normal level (D=0). Alternatively, positive private profits (D>0) are an indication of supernormal returns and should lead to future expansion of the system, unless the farming area cannot be expanded or substitute crops are more privately profitable [12].

**Social profitability:** The second row of the according matrix utilizes social prices, as indicated in Table 7 these valuation measures comparative advantages or efficiency in the agricultural commodity system. Efficient outcomes are achieved when economy's resources are used in activities that create the highest levels of output and income. Social profits, H, are an efficiency measure because outputs, E, and input, F+G, are valued in prices that reflect scarcity values or social opportunity costs. Social profits, like the private analogue, are the difference between revenues and costs, all measured in social prices  $H=(E-F-G)$ . for outputs (E) and inputs (F) that are traded internationally, the appropriate social valuations are given by world prices- (Cost Insurance Freight) import prices for goods or services that are imported or Free on Board export price for exportable [16]. World prices represent the government's choice to permit consumers and producers to import, export, or produce goods or services domestically; the social value of additional domestic output is thus the foreign exchange saved by reducing imports or carried by expanding exports (for each unit of production, the CIF/ import or FOB export price). Because of global output fluctuations or distorting policies abroad, the appropriate world price might not be those that prevail during the base year chosen for the study. Instead, expected long rung values serve as social valuations for tradable output and inputs. The services provided by domestic factors of production-labour, capital and land-do have world prices because the markets for these services are considered to be domestic [13]. The social valuation of each factor service is found by estimation of the net income forgone because the factor is not employed in its best alternative use. The practice of social valuation of domestic factors begins with distinction between mobile and fixed factors of production. Mobile factors, usually capital and labour, are factors that can move from agricultural to other sectors of the economy. For mobile factors, prices are determined by aggregate supply and demand forces. Because alternative uses for these are available throughout the economy, the social values of capital and labour are determined at a national level not solely within the agricultural sector. Fixed, or immobile, factors, of production, are the factors whose private or social opportunity costs

are determined within a particular sector of the economy. The value of agricultural land, for example, is usually determined only by the lands worth in growing alternative crops.

**Effects of divergences (transfers):** The third row, divergences arise from either distorting policies or market failures. Either source of divergences cause observed market prices differ from their counterpart efficiency prices. The symbol I measures divergences in revenues (caused by distortions in output prices), the symbol J stands for divergences in tradable input costs (caused by distortions in tradable input prices), the symbol K represents divergences in domestic factors costs (caused by distortion in domestic factor prices), and the symbol L is the net transfer effect (arising from the total impact of all divergences). According to that principle, all entries in the PAM matrix under the third row equal to the difference between entries in the first row (measured in private prices) and entries in the second row (measured in social prices).

One source of divergences is the existence of a market failure a market fails if it does not generate competitive price that reflect social opportunity costs and lead to an efficient allocation of products or factors. And the second source of divergences is distorting government policy.

### Measures of protection, comparative advantage and competitiveness

**Nominal protection coefficient of output (NPCO):** It reflects the price distortions between the private price and social prices, and measures the extent of policy intervention on the output side; it's a ratio of the price of a commodity actually received by farmers, including the distortions due to government interventions, to computed border equivalent price which would prevail in the absence of market distortions. It measures the deviation of domestic prices from their world or border price equivalent. And it's estimated by dividing the revenue in private prices (A) by the revenue in social prices (E).

$$NPCO = A/E \quad (2)$$

Where, NPCO < 1: The presence of government taxes on outputs; NPCO > 1: The appearance of government subsidies on outputs; NPCO = 1: The absence of government intervention on output.

**Nominal protection coefficient of inputs (NPCI):** It measures the actual divergences or distortions between the domestic prices of tradable input and its border or world price. It measures by dividing the tradable inputs value in private prices (B) by its value in social prices (F).

$$NPCI = B/F \quad (3)$$

Where, NPCI < 1: The presence of government subsidies on inputs; NPCI > 1: The appearance of government taxes on inputs; NPCI = 1: The absence of government intervention on inputs.

**Effective protection coefficient (EPC):** It is a comparison between the value-added measured in private prices (A-B) by the value added measured in social prices (E-F), and it's a measure more efficient to the policy effect so as it assessing the pure impact of the polices on each of the input and output and it can be measured as

$$EPC = (A - B) / (E - F) \quad (4)$$

Where, EPC < 1: Appearance of government taxation's in the system; EPC > 1: Presence of efficiency and comparative advantage to produce a commodity; EPC = 1: Absence of government intervention.

**Domestic resources coefficient (DRC):** DRC ratio assesses

the social returns to domestic resources or social profits. Usually, it measures the efficiency or comparative advantage in order to determine if the production of a specific crop makes efficient use of the domestic resources or not. The DRC is always calculated by dividing the factor costs (G) by the value added in social prices (E-F), which can be formulated in a below equation:

$$DRC = G / (E - F) \quad (5)$$

The result of the calculated equation determines the extent of the efficiency or comparative advantage of producing the commodity. Thus, when it is less than one, it shows the country has comparative advantage in producing a commodity. While, if it is higher than one, this indicates, the DRC value of domestic resources which is used to produce the commodity is higher than the contribution of its value added at social price [17]. The obtained results can be expressed in the below equations [13].

Where, DRC < 1: Presence of efficiency and comparative advantage to produce a commodity; DRC > 1: Absence of efficiency and comparative advantage to produce the commodity; DRC = 1: The absence of government intervention.

**Means of competitiveness international value added:** IVA as an absolute competitiveness measure is defined as a crop revenue less the imported tradable inputs, expressed in foreign currency. It is equal to (A-B) in the side of financial (Private) analysis, or (E-F) in the economic (Social) analysis side. A crop with positive (IVA) indicates positive foreign exchange earnings or saving. The principal defect of such a measure is that it neglects the domestic factors [13].

$$IVA = E - F \quad (6)$$

## Results and Discussion

### Price incentives and efficiency of resource use

**Output price incentives:** The results of the PAM analysis are presented in Table 8 These results show the calculated nominal protection coefficients (NPCs) for the selected export crops. The NPC is used to measure the output price incentives provided by the adopted policy. This ratio is estimated by dividing the revenue in private prices (A) by the revenue in social prices (E). It measures the extent of policy intervention on output side. If this ratio is less than one, it shows the presence of taxes on outputs. If the NPC is greater than one, it indicates the presence of subsidies. When the NPC is equal to or close to one (in the absence of market failure) it reveals the absence of government intervention in the output market [11].

As it can be seen from Table 8, the calculated NPCs for the selected export crops during the period under analysis are greater than one, with the exception of melon, whose NPC averaged about 0.62. This result means that the adopted government policy provided significant price incentives to the selected export crops. The explanation for the fact that

| Seasons | Crops |       |       |        |
|---------|-------|-------|-------|--------|
|         | Onion | Melon | Mango | Banana |
| 2009/10 | 2.91  | 0.7   | 4.37  | 1.49   |
| 2010/11 | 1.97  | 0.83  | 2.95  | 1.6    |
| 2011/12 | 0.96  | 0.77  | 1.49  | 1.34   |
| 2012/13 | 1.87  | 0.41  | 1.1   | 1.17   |
| 2013/14 | 1.43  | 0.39  | 4.45  | 1.21   |
| Average | 1.82  | 0.62  | 2.87  | 1.36   |

**Table 8:** The nominal protection coefficients of output (NPCOs) for the selected export crops, 2009-2013.

mango, onion and banana exports are subsidized while melon export is taxed can be attributed to the high cost of production of melon and its relatively low productivity as compared to the other crops for which the climate is conducive.

**Input price incentives:** The input price incentives are measured by the nominal protection coefficient on inputs (NPI). The (NPI) is a similar calculation to the (NPC) applied to tradable inputs. It is calculated by dividing the value of tradable inputs at private prices by the value of tradable inputs at social prices. If the value of (NPI) is low, it implies a positive protection to farmers through input subsidy by the government, whereas a high ratio implies the opposite, i.e., inputs are taxed by the government.

The PAM results obtained for the nominal protection coefficients of inputs (NPI) are presented in Table 9. Most of the obtained NPIs for the selected export crops are less than one during the analyzed period. These results indicate that the adopted policy encouraged the production of the selected export crops through subsidization of the inputs used for production of these crops during the period under analysis.

**The overall production incentives:** In calculating the (NPC), no account is taken of the subsidies or levies on inputs. To correct for this defect allowance for distortions on both input and output prices is made by calculating the (EPC). The (EPC) measures the protection according to the value added rather than final product. It is calculated in the PAM by the ratio of the value added measured at market prices (A-B) to the value added measured at social prices (E-F). If the calculated ratio of (EPC) is greater than one, this indicates that the protective measures provide positive incentives to produce the commodity. A (EPC) which is less than one, on the other hand, implies net disincentives and taxation's in the system.

With the exception of melon, the calculated EPCs for the selected export crops were greater than unity (Table 10). This result indicates the presence of efficiency and comparative advantage in producing those crops in 2009-2013 as a result to the heavy support provided by the adopted government policy throughout the analyzed period.

| Seasons | Crops |       |       |        |
|---------|-------|-------|-------|--------|
|         | Onion | Melon | Mango | Banana |
| 2009/10 | 0.26  | 0.32  | 0.13  | 0.11   |
| 2010/11 | 0.27  | 0.3   | 0.13  | 0.22   |
| 2011/12 | 0.27  | 0.3   | 0.13  | 0.21   |
| 2012/13 | 0.27  | 0.32  | 0.13  | 0.21   |
| 2013/14 | 0.33  | 0.32  | 0.12  | 0.21   |
| Average | 0.28  | 0.31  | 0.13  | 0.19   |

Table 9: The nominal protection coefficients of inputs (NPIs) for the selected export crops, 2009-2013.

| Seasons | Crops |       |       |        |
|---------|-------|-------|-------|--------|
|         | Onion | Melon | Mango | Banana |
| 2009/10 | 4.27  | 0.74  | 5.52  | 1.69   |
| 2010/11 | 2.57  | 0.87  | 3.37  | 1.78   |
| 2011/12 | 1.06  | 0.81  | 1.58  | 1.46   |
| 2012/13 | 2.42  | 0.45  | 1.14  | 1.25   |
| 2013/14 | 1.87  | 0.4   | 5.35  | 1.29   |
| Average | 2.43  | 0.65  | 3.39  | 1.49   |

Table 10: The effective protection coefficients EPC for the selected export crops, 2009-2013.

### Competitiveness of cultivation of the selected export crops

**Relative competitiveness:** The ability of the cultivated crop to make efficient use of the domestic resources or not is measured by the domestic resource coefficient (DRC). The DRC as a measure of efficiency or comparative advantage is calculated by dividing the factor costs by the value added in social prices. A domestic resource coefficient value greater than one indicates that the value of domestic resources used to produce the commodity is greater than the contribution of its value added at social price. A DRC value less than one; indicate that the country has comparative advantage in producing that commodity.

The changes in relative competitiveness of the selected export crops cultivated during 2009-2013 are shown in Table 11. It appears that relative competitiveness fluctuated among the crops in any one year and within the same crop over the analyzed years. As it can be seen, all of the selected export crops appeared to be competitive all over the analyzed period. The ability of the selected export crops to use the available domestic factors efficiently is the result of the adaptability of these crops to the climatic factors and soil conditions of the various cultivation centers. Based on that, it could be concluded that the adopted policy managed to realize significant improvement in the efficiency of the cultivated crops to use domestic resources.

**International competitiveness:** The results of international competitiveness (IVA) of the selected export crops are presented in Table 12. It appears that in terms of international value, all of the selected export crops, especially melon and mango, are more competitive. The relatively lower international competitiveness of onion as compared to the other selected export crops can be explained by the low yields of onion due to the climatic unsuitability of some production centers of onion (for example, the Gezira area) and the low input intensity level for onion production.

Also, the estimated IVAs reflected high variability in international competitiveness of the studied crops during the analyzed years, both within the crops in any one year and within the same crops in the different years. This variability was due primarily to changes in exchange rate, in addition to changes in yields and annual changing world prices.

| Seasons | Crops |       |       |        |
|---------|-------|-------|-------|--------|
|         | Onion | Melon | Mango | Banana |
| 2009/10 | 0.51  | 0.08  | 0.27  | 0.15   |
| 2010/11 | 0.35  | 0.08  | 0.15  | 0.13   |
| 2011/12 | 0.19  | 0.1   | 0.07  | 0.1    |
| 2012/13 | 0.45  | 0.39  | 0.05  | 0.08   |
| 2013/14 | 0.48  | 0.03  | 0.21  | 0.08   |
| Average | 0.4   | 0.13  | 0.15  | 0.1    |

Table 11: The domestic resource coefficient (DRC) for the selected export crops, 2009-2013.

| Seasons | Crops |       |       |        |
|---------|-------|-------|-------|--------|
|         | Onion | Melon | Mango | Banana |
| 2009/10 | 1818  | 14146 | 3098  | 6333   |
| 2010/11 | 3001  | 15030 | 6638  | 7972.4 |
| 2011/12 | 8199  | 14866 | 17021 | 12175  |
| 2012/13 | 3823  | 4487  | 27441 | 16981  |
| 2013/14 | 4806  | 59146 | 5700  | 19232  |
| Average | 4329  | 21535 | 11980 | 12539  |

Table 12: The international value added for the selected export crops, 2009-2013.

## Summary, Conclusions and Recommendations

### Summary

The agricultural sector of Sudan represents the most important sector of the economy. The area estimated to about 1.882 thousand kilometer square and it's classified as one of the largest country in Africa. The total area of the agricultural land in Sudan is approximately 200 million feddans of which 40 million feddans is cultivated which is amount to about 20% of the total arable area for agricultural production. Despite all these opportunities, the production and export of horticultural products remain extremely weak.

This study aims at the examination of the capacity of the potential demand markets for horticultural products from Sudan as well as assessing the productive capacities for an expanded horticultural production. In addition to that, to assess the impact of the adopted government policies as regard to outputs, producer's incentives and resources use.

The most important questions of this study was about the incentives provided by the adopted government policies toward export of horticultural products, the competitiveness of the exported horticultural crops.

The study relies on secondary data pertaining the period of 2009-13 which were obtained from government publications. The study used the policy analysis matrix (PAM) technique to analyze the impact of government policy on exports, producer's incentives and competitiveness of horticultural crops production in Sudan. The results of PAM analysis show that the adopted government policies had a positive impact on the production of vegetables and fruit crops in terms of protection, competitiveness and comparative advantages during the period 2009-2013.

### Conclusions

This study has attempted to analyze the impact of the government policies on the production of vegetables and fruits. The (PAM) results show that the ratios of (NPCs) for the selected export crops during the analyzed period are greater than one, with the exception of melon, who's NPC about 0.62. This result means that the adopted government policy provided significant price incentives to the selected export crops. The explanation for the fact that mango, onion and banana exports are subsidized while melon export is taxed and this attributed to the high cost of production of melon and its relatively low productivity as compared to the other crops for which the climate is conducive.

The PAM results obtained for the (NPIs) selected export crops are less than one during the analyzed period. These results indicate that the adopted policy encouraged the production of the selected export crops through subsidization of the inputs used for production of these crops during the period under analysis.

The calculated (EPCs) for the selected export crops were greater than unity, with the exception of melon. This result indicates the presence of efficiency and comparative advantage in producing those crops in 2009-2013 as a result to the heavy support provided by the adopted government policy throughout the analyzed period.

The DRC in all of the selected export crops appeared to be competitive all over the analyzed period. The ability of the selected export crops to use the available domestic factors efficiently is the result of the adaptability of these crops to the climatic factors and soil

conditions of the various cultivation centers. Based on that, it could be concluded that the adopted policy managed to realize significant improvement in the efficiency of the cultivated crops to use domestic resources.

Also, the estimated IVAs reflected high variability in international competitiveness of the studied crops during the analyzed, both within the crops in any one year and within the same crops in the different years. This variability was due primarily to changes in exchange rate, in addition to changes in yields and annual changing in world prices.

### Recommendations

- Providing extra Governmental subsidies to the importing inputs for the production, the harvest, and post-harvest operations.
- Expand and diversify the product base of horticultural exports.
- Adoption of appropriate technical packages to develop the total output of horticultural exports and improving its quality.
- Reform the structure of the marketing and export system.
- Self-autarchy of improved seeds and seedling is highly recommended.

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