Nat. Volatiles & Essent. Oils, 2021; 8(5): 9945-9959

NVEO
Natural Volatiles & Essential Oils

Analysis and prediction of Dynamic Change of Cultivated Land Pressure Based on Food Security in Egypt

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Abstract

This study aimed to explore and predict the impact of food security on dynamic cultivated land demandin the case of Egypt. Through using the pressure index model based on food security indicators for the most important strategic crops groups (grain crops, oil crops, and legume crops) in old and new lands over the period (2000-2020). The empirical findings show that the self-sufficiency ratio of grain crops, oil crops, and legume crops was decreased by 39.9%, 76%, and 68% respectively. While, the value of the food security coefficient was less than one; which, leads to dependence on foreign countries for food supplies. Also, threatened the food security of Egypt. The pressure index on cultivated land for the most important strategic crops groups strategic is less than 1 in old and new lands. Meaning the actual cultivated land per capita is greater than the minimum area cultivated land per capita and is not reached to alarm value. This indicates the old and new lands are still able to achieve self-sufficiency from grain crops, oil crops, and legume crops. In 2030, the pressure Index of cultivated land would reach 1 of grain crops, legume crops, and 0.3 of oil crops group, which means the ability of cultivated land to meet future rates and be self-sufficient. This search represents the first attempt to explore the impact of food security on dynamic demand for cultivated land in the context of achieving SDGs in Egypt.

Key Words: Self-sufficiency ratio, Coefficient of food security, pressure index model, grain crops, oil crops, and legume crops.

1. Introduction

Food security is one of the goals of the 2030 Agenda for Sustainable Development [1, 2], which calls for achieving food security and sustainable agriculture. According to the SDGs Report for 2020, 25.9% of the human population was affected by moderate [3] to severe food insecurity in 2019, rising from 22.4% (about 2 billion people) in 2014 [4]

According to the updated Strategy for Sustainable Agricultural Development in Egypt 2030, the agricultural sector is an essential sector in the Egyptian economy and a major pillar of food security. Hence, achieving self-sufficiency is considered one of the goals of agricultural policy[5]. Egypt also is ranked 60 out of 113 nations for the 2020 Global Food Security Index [6].

Cultivated land is an essential key of the land resources which directly affect a country's food security [7].The amount of cultivated land depends primarily on the population number, crops group area, crops yield, and both the minimum cultivated land and per capita actual area change with time [8]. In Egypt, the cultivated area does not increase at the same rate as the population increase; the annual population grows by 2.4% [9].Therefore, it contributed to pressure on cultivated lands to meet the population's food needs.

The arable lands area is estimated to be around 14 million Feddan is represented about 6% of the Egyptian territory. While the area of cultivated land in Egypt reached about 9.51 million Feddan in 2020, up by 1.6 million Feddan compared to 1990. These areas vary in their production capacity from one

region to another, where small areas (less than 5 Feddan) represent about 92% of agricultural landholdings.

Cultivated land consists of old lands in the Nile Valley and Delta, new lands. The old lands represent the largest irrigated area in Egypt and are found in the Nile Valley and Delta, mostly using water from the Nile. While the new lands include lands that have been reclaimed were the area of reclaimed land reached 115.7 thousand feddan in 2018/2019 compared to 59.2 thousand feddan in 2017/2018, up by 95.4% [10].

Despite the government's efforts, the Ministry of Agriculture and Land Reclamation (MALR), towards increasing cultivated land to meet the population's food needs, is still highly dependent on food imports because of the low rates of self-sufficiency, especially from strategic food groups as grain groups, oil groups, and legumes groups. The rates of self-sufficiency of grain groups, oil groups, and legumes groups were estimated at 42.3%, 13.3%, and 7.82% in 2020, respectively [11] because of, suffering deficiencies in production to meet the human's food consumption.

This search, to the best of our knowledge, represents the first attempt to explore the impact of food security for grain groups, oil groups, and legume groups on dynamic demand for cultivated land in the context of achieving SDGs in Egypt.

Then the main objective of the study was to analyze and predict dynamic cultivated land demand based on food security for three crops groups strategic, growing in both old land and new land in Egypt, thus getting an overview extent to which agricultural lands are able to contribute to achieving food security from the three crop groups during:

1- Estimate of coefficient of food security for three crops groups strategic; 2- Study changes that occurred in the area of cultivated land, and recognize the per capita actual of cultivated land; 3- Estimate of the pressure index on cultivated lands according to the groups of field crops; 4- Predicting the change in demand for agricultural land in 2030.

2. Data and method:

2.1. Data source:

Data of research such as cultivated land, crop yield were collected from the Economic Affairs Sector, Ministry of Agriculture, and Land Reclamation (MALR). Data on self-sufficiency and the consumption average population number were collected from Central Agency for Public Mobilization and Statistics (CAPMAS).

2.2. Research method:

To achieve research goals depends on using quantitative and qualitative analyses through indicators of food security and Pressure Index model according to the following equations:

First, food security indicators:

$$SSR = {Q}/{C} \ *100 \qquad (1)$$

$$QSDC = ((SPPC + ICPC) - 365) * C_{perday} \qquad (2)$$

$$SPPC = {QSDC}/{C_{Perday}} \qquad (3)$$

$$QDDC = (365 - (SPSC + ICPC)) * C_{Perday} \quad (4)$$

$$SDC = QDDC / C_{Perday} \quad (5)$$

$$QCSS = QSDC - QDDC \quad (6)$$

$$CFS = QCSS / C \quad (7)$$

Where, Q is the quantity of Production; C is the quantity of Consumption (1000 tons); SSR is the self-sufficiency Ratio; C_{perday} is the Daily local consumption; SPPC is the Sufficiency period of production for consumption (day); ICPC is the Imports coverage period for consumption (day); QSDC is the Quantity of surplus in domestic consumption (1000 tons); SPSC is the Sufficiency period of the surplus for domestic consumption (day); QDDC is the Quantity of deficit in domestic consumption (1000 tons); SDC is the Sufficiency of the deficit in consumption (day); QCSS is the Quantity of change in the size of the strategic stock (1000 tons) ;and CFS is the Coefficient of food security.

Second, pressure index model [12-15]:

$$S_{min} = B * C/(pqd) \quad (8)$$

$$K = S_{min} / S_a \quad (9)$$

Where, S_{in} is the minimum cultivated land per capita; B is the self-sufficiency (%); C is Per capita consumption average Kg /people; p is the unit productivity, q is the area devoted to crop production (%); d is the multiple cropping index or cropping density; K is the pressure Index; and Sa is the actual cultivated land per capita.

Table 1 shows the pressure index of cultivated land is the ratio between the minimum cultivated land area per capita to the actual cultivated land area per capita [16] represented by (K) [8]. K is reflected pressure status of cultivated land as shown. While table 2 shows the cultivated land pressure index that was divided into three degree.

2.3. Selected crops

The study considers crops groups' strategies divided into three groups main consumption categories: (1) grain crops group divided into winter crops and summer crops; Wheat and Barley are winter crops, Rice, Summer maize (white &yellow), and Sorghum are summer and nili crops; (2) legume crops group; Broad beans, Lentil, Chickpeas, Lupine, and Dry Fenugreek are winter crops; (3) oil crops group included Soybeans, Peanuts, Sesame, and Sunflower are summer and nili crops.

Table 1: The cultivated land pressure index

pressure index	*Meaning*	*Statue*
$K < 1$	minimum cultivated land per capita is less than actual per capita cultivated land	Without cultivated land pressure
$K > 1$	minimum cultivated land per capita is less than actual per capita	On the limit of pressure
$K = 1$	minimum cultivated land per capita is equal actual per capita cultivated land	clear cultivated land pressure

Table 2: The class of cultivated land pressure index

Issue	*Level1*		*Level 2*		*Level 3*		
Pressure Index	<0.50	0.51-0.90	0.91-1.00	1.01-1.10	1.11-1.50	1.51-2.00	> 2.01
Representation stale	Small	Smaller	Slightly Small	Slightly large	Larger	Large	Very Larger

3. Result and analysis

3.1. Estimating Food security indicators of grain crops group:

Daily local consumption: Table 3 shows that daily local grain consumption quantity ranged between a minimum limit of about 69.7 thousand tons in 2000, and a maximum limit of around 141.1 thousand tons in 2020, with an annual average of 95.8 thousand tons, daily local grain consumption 2020 increased by 103% compared with 2000; due to increasing in population, along with the increase in demand on grain crops, whether for human or animal consumption.

Sufficiency period of production for consumption: The minimum limit was estimated at about 147.3 days in 2020, and a maximum limit of about 310.6 days in 2009 with an average of about 228.7 days. **Imports coverage period for consumption:** The minimum was calculated at about 76.6 days in 2009, while the maximum was about 186.2 days in 2018, with an average of 135.8 days. This indicates Egypt's increasing dependence on imports from foreign countries to meet its needs of grain crops, due to the inability of local production to meet the increasing demand for grain crops.

Surplus and deficit in local consumption: The total quantity surplus of grain crops' local consumption during the study period was reached around 9.77 million tons that were enough for around 119 days. While the total quantity deficit of grain crops local consumption about was 16.9 million tons (i.e. 130 days); to overcome the food gap of grain crops and achieve strategic surplus must be increased food security ratio of grain crops.

The quantity of change in the size of the strategic stock: The minimum limit of change in the strategic stock was estimated at about 105 thousand tons in 2013, While, maximum limit was about 5.9 million tons in 2020, with an average of around 1270 thousand tons. That indicates the necessity be increase the strategic stock of those crops, which suffers from a deficit between production and consumption to be used to cover a portion of consumption during deficit periods.

Food security coefficient: The average value of the food security coefficient during the period (2000 - 2020) was estimated at about 0.032. It is necessary to increase the food security coefficient to reach at least 0.5. In order to expand the size of the strategic stock to fulfill the local consumption needs of the population and with at least six months, according to food security concerns, by the adoption of policies and executive programs.

Table 3: Food security indicators for grain crops in Egypt during the period (2000-2020)

Years	Daily local consumption (1000/tons)	Sufficiency period of production for consumption (day)	Imports coverage period for consumption (day)	Surplus		Deficit		strategic stock (1000/tons)	Coefficient of food security
				Quantity (1000/tons)	Sufficiency Period (day)	Quantity (1000/tons)	Sufficiency (day)		
2000	69.7	245.0	116.4	-	-	-246.0	-3.5	246.0	0.010
2001	71.3	248.1	129.3	881	12.4	-	-	881.0	0.034
2002	77.6	235.5	132.8	257	3.3	-	-	257.0	0.009
2003	71.3	258.8	113.9	543	7.6	-	-	543.0	0.021
2004	69.8	276.7	97.4	630	9.0	-	-	630.0	0.025
2005	82.9	254.3	130.2	1615	19.5	-	-	1615.0	0.053
2006	82.3	253.6	116.6	426	5.2	-	-	426.0	0.014
2007	81.7	245.3	128.7	732	9.0	-	-	732.0	0.025
2008	89.7	238.3	139.5	1151	12.8	-	-	1151.0	0.035
2009	77.9	310.6	76.6	1725	22.1	-	-	1725.0	0.061
2010	98.9	215.2	148.5	-	-	-124.0	-1.3	124.0	0.003
2011	99.8	207.4	168.4	1078	10.8	-	-	1078.0	0.030
2012	88.9	250.8	111.2	-	-	-269.0	-3.0	269.0	0.008
2013	102.1	238.6	127.5	105	1.0	-	-	105.0	0.003
2014	100.3	237.5	123.8	-	-	-367	-3.7	367.0	0.010
2015	110.0	218.5	143.2			-359	-3.3	359.0	0.009
2016	107.2	212.5	158.3	625	5.8			625.0	0.016
2017	130.1	172.1	162.7			-3935	-30.3	3935.0	0.083
2018	127.8	176.5	186.2			-296	-2.3	296.0	0.006
2019	131.1	159.7	163.9			-5422	-41.3	5422.0	0.113
2020	141.4	147.3	176.1			-5883	-41.6	5882.5	0.114
Sum	2011.7	4802.1	2851.2	9768	119	-16901	-130	26669	0.682
Average	95.8	228.7	135.8	814	10	-1878	-14.4	1270	0.032

3.2. Estimating Food security indicators of legume crops group in Egypt:

Daily local consumption: Table 4 showed that the minimum limit of daily legume crops consumption amount was estimated at about 1.5 thousand tons in 2012 & 2015, While the maximum limit of around 3.4 thousand tons in 2018, with an annual average of about 2.3 thousand tons. But it was increased in 2020 by 26% compared with 2000. An increase in the local consumption of legume crops group may be the result of the population increasing and different levels of income.

Table 4: Food security indicators for legume crops in Egypt during the period (2000-2020)

Years	Daily local Consumption (1000/tons)	Sufficiency period of Production for consumption (day)	Imports period for consumption (day)	Surplus		Deficit		strategic stock (1000/tons	Coefficient of food security
				Quantity (1000/tons)	Sufficiency Period (day)	Quantity (1000/tons)	Sufficiency (day)		
2000	2.3	235.1	140.5	25	10.6			25.0	0.029
2001	2.3	226.6	158.9	48	20.6			48.0	0.056
2002	2.4	212.0	172.7	47	19.7			47.0	0.054
2003	2.3	214.5	175.0	55	24.4			55.0	0.067
2004	2.3	184.5	196.5	36	16.0			36.0	0.044
2005	2.4	157.9	221.8	35	14.6			35.0	0.040
2006	2.1	166.0	268.1	147	69.1			147.0	0.189
2007	2.2	184.3	188.4	17	7.7			17.0	0.021
2008	2.7	134.5	280.7	137	50.2			137.0	0.138
2009	2.5	156.6	103.6			-263.0	-104.8	263.0	0.287
2010	1.9	166.8	172.5			-50.0	-25.7	50.0	0.070
2011	2.0	152.0	227.9	30	14.9			30.0	0.041
2012	1.5	160.2	258.9	79	54.1			79.0	0.148
2013	2.3	121.2	294.7	115	50.9			115.0	0.139
2014	1.7	177.1	268.0	133	80.1			133.0	0.219
2015	1.5	174.7	272.8	127	82.5			127.0	0.226
2016	2.1	106.2	320.1	130	61.4			130.0	0.168
2017	2.2	148.0	301.5	185	84.5			185.0	0.232
2018	3.4	77.9	336.3	168	49.2			168.0	0.135
2019	2.4	105.8	460.8	480	201.6			480.0	0.552
2020	2.9	73.1	366.2	573	74			573	0.204
Sum	47.4	3335.2	5185.8	2567	986	-313	-131	2697	3.06
Average	**2.3**	**158.8**	**246.9**	**135**	**52**	**-157**	**-65**	**128**	**0.146**

Sufficiency period of production for consumption: The minimum limit was estimated at about 73.1 days in 2020, and a maximum limit of about 235.1 days in 2000 with an average of about 158.8 days.

Imports coverage period for consumption: The minimum was calculated at about 103.6 days in 2009, and the maximum was about 460.8 days in 2019, with an average of 246.9 days. This indicates lower food security indicators for legume crops, as the period of import coverage for consumption was greater.

Surplus and deficit in local consumption: The total quantity surplus of legume crops' local consumption during the study period was reached around 2.6 million tons that were enough for around 986 days. While the total quantity deficit of legume crops local consumption about was 313 thousand tons (i.e. 131 days); to control the food gap of legume crops and achieve strategic surplus must be increased food security ratio of legume crops.

The quantity of change in the size of the strategic stock: The minimum limit of change in the strategic stock was estimated at about 17 thousand tons in 2007, while, maximum limit was about 573 thousand tons in 2020, with an average of around 128 thousand tons. As a result, in order to cover a portion of consumption, it is required to increase the strategic stock of legume crops that are experiencing a production shortfall during deficit periods.

Food security coefficient: The Average value of the food security coefficient during the period (2000-2020) was estimated at about 0.146. It is necessary to increase the value of the food security factor until it reaches about 0.5 by implementing appropriate policies and initiatives to meet the population's consumption.

3.3. Estimating Food security indicators of oil crops group:

Daily local consumption: Table 5 showed that daily local oil crops consumption amount ranged between a minimum limit of about 1.8 thousand tons in 2015, and a maximum limit of around 17.1 thousand tons in 2020. And it was increased by 388.5% in 2020 compared with 2000; due to an increase in population, along with the increase in demand.

Sufficiency period of production for consumption: The minimum limit was estimated at about 29.9 days in 2020, while a maximum limit of about 295.1 days in 2003 with an average of about 170.8 days. **Imports coverage period for consumption:** The minimum was calculated at about 73.4 days in 2003, and the maximum was about 332.4 days in 2020, with an average of 202.6 days. This indicates lower food security indicators for oil crops as a result, the period of import coverage for consumption was greater.

Surplus and deficit in local consumption: The total surplus of oil crops' local consumption during the period (2000-2020) was reached around 654 thousand tons that were enough for around 218 days. While the total deficit of oil crops local consumption about was 203 thousand tons (i.e., 40 days). Therefore, to overcome the food gap of oil crops and achieve strategic surplus must be an increased production ratio of oil crops.

The quantity of change in the size of the strategic stock: The minimum limit of change in the strategic stock was estimated at about 8 thousand tons in 2002, while, maximum limit was about 122 thousand tons in 2017, with an average of around 40.8 thousand tons. That indicates the necessity be increase the strategic stock of those crops, which suffers from a deficit between production and consumption to be used to cover a portion of consumption during deficit periods.

Food security coefficient: The Average value of the food security coefficient during the period (2000-2020) was estimated at about 0.034. It is necessary to increase the value of the food security factor until it reaches about 0.5 by implementing appropriate policies and initiatives to meet the population's consumption.

. **Table 5: Food security indicators for oil crops in Egypt during the period (2000-2020)**

Years	Daily local consumption (1000/tons)	Sufficiency period of production for consumption (day)	Imports coverage period for consumption (day)	Surplus		Deficit		strategic stock (1000/tons)	Coefficient of food security
				Quantity (1000/tons)	Sufficiency Period (day)	Quantity (1000/tons)	Sufficiency (day)		
2000	3.5	227.2	113.7			-84.0	-24.1	84.0	0.066
2001	3.4	237.2	116.7			-38.0	-11.2	38.0	0.031
2002	3.3	247.7	119.8	8	2.4			8.0	0.007
2003	2.6	295.1	73.4	9	3.4			9.0	0.009
2004	2.8	279.0	89.5	10	3.5			10.0	0.010
2005	3.5	198.6	168.9	9	2.5			9.0	0.007
2006	3.5	198.0	173.0	21	6.0			21.0	0.016
2007	4.9	132.9	235.4	16	3.3			16.0	0.009
2008	2.6	251.2	124.2	27	10.4			27.0	0.029
2009	2.8	178.5	208.0	60	21.6			60.0	0.059
2010	2.7	174.1	206.2	41	15.3			41.0	0.042
2011	10.3	51.1	315.9	20	1.9			20.0	0.005
2012	3.1	167.7	208.2	34	10.9			34.0	0.030
2013	4.7	102.0	273.9	51	10.9			51.0	0.030
2014	2.2	196.9	188.7	45	20.6			45.0	0.056
2015	1.8	258.8	129.1	40	22.8			40.0	0.063
2016	3.4	118.7	269.9	81	23.6			81.0	0.065
2017	2.3	163.4	254.1	122	52.4			122.0	0.144
2018	10.1	44.2	326.7	60	5.9			60.0	0.016
2019	13.8	35.7	326.7			-35.0	-2.5	35.0	0.007
2020	17.1	29.9	332.4			-45.5	-2.7	45.5	0.007
Sum	104.4	3587.8	4254.5	654	218	-203	-40	857	0.707
Average	**5.0**	**170.8**	**202.6**	**38**	**13**	**-51**	**-10**	**40.8**	**0.034**

4. Estimating Pressure on cultivated land

4.1 The change in the area of cultivated land: Table 6 referred to the total cultivated area estimated at 7831 thousand feddan in 2000 reached 9509 thousand feddan in 2020, up by 21.4 %; due to an increase in new land about 2045 thousand feddan (i.e. 128.3%), the result of horizontal expansion; where the state pays attention to supporting projects of horizontal expansion of the cultivated area through several important national projects. While the old lands area of cultivated tends to decrease about 367 thousand feddan (i.e. 5.88%), the result of encroachments on agricultural lands.

Table 6: Change of Cultivated area, Population and actual cultivated land area per capita at level old land, new land and at total country during (2000-2020).

Years	Cultivated area at the old lands (1000 feddan)	Cultivated area at the new lands (1000 feddan)	Cultivated area at the country (1000 feddan)	Population (million people)	actual cultivated land area per capita at the old lands (feddan / people)	actual cultivated land area per capita at the new lands (feddan / people)	actual cultivated land area per capita at the country (feddan / people)
2000	6237	1594	7831	63.3	0.098	0.025	0.123
2001	6405	1540	7945	64.6	0.099	0.023	0.122
2002	6487	1661	8148	65.9	0.099	0.026	0.124
2003	6458	1655	8113	67.3	0.097	0.025	0.122
2004	6623	1655	8278	68.6	0.096	0.025	0.121
2005	6648	1736	8384	69.9	0.094	0.024	0.119
2006	6656	1755	8411	71.3	0.094	0.025	0.119
2007	6536	1887	8423	72.9	0.089	0.026	0.115
2008	6454	1978	8432	74.4	0.087	0.026	0.113
2009	6157	2627	8784	76	0.082	0.034	0.116
2010	6118	2623	8741	77.8	0.078	0.033	0.112
2011	6071	2548	8619	79.6	0.077	0.031	0.108
2012	6019	2780	8799	81.6	0.074	0.034	0.108
2013	6183	2772	8955	83.7	0.074	0.033	0.108
2014	6082	2834	8916	85.8	0.071	0.033	0.104
2015	6156	2940	9096	87.9	0.071	0.033	0.104
2016	6148	2954	9102	90	0.068	0.032	0.100
2017	5985	3148	9133	92.1	0.065	0.034	0.099
2018	5989	3203	9192	96.3	0.061	0.033	0.096
2019	5916	3417	9333	98.1	0.060	0.035	0.096
2020	5870	3639	9509	102	0.059	0.034	0.093
Average	**6248**	**2426**	**8674**	**79**	**0.081**	**0.030**	**0.111**

4.2 . Actual cultivated land area per capita: Table 6 showed that the total actual cultivated area per capita decreased from about 0.123 (feddan/people) to 0.093 (feddan/people) with an average of 0.111 (feddan/people) during the study period, due to the average actual per capita of the cultivated land in the old land decreased about 0.039 (feddan/people) because of the encroachments that took place on the lands in the past periods. While the average actual per capita of cultivated land in the new land increased about 0.010 (feddan / people) result of horizontal expansion.

4.3 . Measuring The cultivated land pressure index of grain crops group: Table 7 showed that the pressure index of cultivated land for grain crops group is less than one during the period 2000 to 2020 at old and new lands; this means that actual per capita of the cultivated land area is greater than minimum cultivated land per capita which is not reached to alarm value. This indicates the ability of cultivated lands in old and new lands to achieve Self-sufficiency from grain crops. The decline in the cultivation of grain crops may be due to the tendency of farmers to plant cash crops.

Table 7: The cultivated land pressure index of grain crops group during (2000-2020)

Years	old land		new land		Total country	
	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index
2000	0.069	0.70	0.018	0.70	0.072	0.58
2001	0.063	0.66	0.015	0.64	0.066	0.54
2002	0.062	0.65	0.016	0.63	0.058	0.47
2003	0.067	0.72	0.017	0.70	0.072	0.60
2004	0.070	0.77	0.018	0.73	0.075	0.63
2005	0.061	0.68	0.016	0.64	0.071	0.59
2006	0.062	0.71	0.016	0.66	0.071	0.60
2007	0.057	0.67	0.017	0.64	0.067	0.58
2008	0.054	0.64	0.016	0.62	0.067	0.60
2009	0.058	0.70	0.025	0.71	0.080	0.69
2010	0.043	0.54	0.018	0.55	0.062	0.55
2011	0.041	0.52	0.017	0.53	0.055	0.51
2012	0.044	0.57	0.020	0.59	0.061	0.57
2013	0.041	0.55	0.018	0.55	0.055	0.52
2014	0.039	0.54	0.018	0.55	0.056	0.54
2015	0.033	0.47	0.016	0.47	0.047	0.45
2016	0.033	0.48	0.016	0.49	0.047	0.47
2017	0.028	0.42	0.015	0.43	0.041	0.41
2018	0.028	0.43	0.015	0.45	0.043	0.45
2019	0.026	0.41	0.015	0.43	0.041	0.43
2020	0.026	0.43	0.016	0.45	0.040	0.43

4.4 . Measuring The cultivated land pressure index of legume crops group: Table 8 showed the pressure index on cultivated land of legume crops group estimated at less than 1 from the year 2000 to 2020 at old and new lands; this means pressure index on cultivated land of legume crops is greater than minimum cultivated land per capita that is not reached to alarm value. This designates cultivated lands in old and new lands to achieve Self-sufficiency from legume crops.

4.5 Measuring The cultivated land pressure index of oil crops group: Table 9 showed that pressure index on cultivated land of oil crops group is less than 1 during the period (2000 – 2020) at old and new lands; this means that actual per capita of the cultivated land area is greater than minimum cultivated land per capita and is not reached to alarm value. This indicates the ability of cultivated lands in old and new lands to achieve Self-sufficiency from oil crops.

Table 8: The cultivated land pressure index of legume crops group during (2000-2020)

Years	old land		new land		Total country	
	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index
2000	0.051	0.52	0.015	0.58	0.066	0.53
2001	0.065	0.65	0.016	0.65	0.082	0.67
2002	0.077	0.78	0.020	0.78	0.094	0.76
2003	0.075	0.78	0.022	0.89	0.094	0.78
2004	0.075	0.78	0.021	0.87	0.091	0.75
2005	0.075	0.78	0.023	0.93	0.091	0.76
2006	0.081	0.87	0.021	0.87	0.081	0.87
2007	0.071	0.79	0.020	0.79	0.071	0.79
2008	0.069	0.79	0.021	0.79	0.069	0.80
2009	0.066	0.81	0.028	0.81	0.066	0.81
2010	0.078	1.00	0.034	1.00	0.112	1.00
2011	0.059	0.78	0.025	0.78	0.084	0.78
2012	0.059	0.80	0.027	0.80	0.086	0.80
2013	0.057	0.77	0.024	0.72	0.080	0.75
2014	0.053	0.75	0.025	0.75	0.074	0.71
2015	0.056	0.80	0.028	0.84	0.083	0.80
2016	0.063	0.92	0.030	0.92	0.093	0.92
2017	0.063	0.97	0.032	0.94	0.094	0.95
2018	0.059	0.94	0.031	0.94	0.091	0.95
2019	0.058	0.96	0.034	0.98	0.092	0.96
2020	0.055	0.96	0.035	0.98	0.088	0.95

Table 9: The cultivated land pressure index of oil crops group during (2000-2020)

Years	old land		new land		Total country	
	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index	Minimum cultivated land per capita	Pressure Index
2000	0.056	0.56	0.014	0.14	0.070	0.57
2001	0.047	0.48	0.011	0.12	0.060	0.49
2002	0.032	0.33	0.008	0.08	0.040	0.33
2003	0.031	0.32	0.008	0.08	0.040	0.33
2004	0.033	0.34	0.008	0.09	0.042	0.35
2005	0.024	0.25	0.006	0.07	0.031	0.26
2006	0.039	0.42	0.010	0.11	0.050	0.42
2007	0.025	0.28	0.007	0.08	0.032	0.28
2008	0.044	0.50	0.013	0.15	0.059	0.52
2009	0.033	0.41	0.014	0.18	0.047	0.41
2010	0.030	0.38	0.013	0.16	0.042	0.38
2011	0.036	0.48	0.015	0.20	0.053	0.49
2012	0.035	0.47	0.016	0.22	0.052	0.48
2013	0.022	0.30	0.010	0.14	0.032	0.30
2014	0.049	0.69	0.023	0.32	0.073	0.70
2015	0.064	0.91	0.030	0.43	0.094	0.91
2016	0.037	0.55	0.018	0.26	0.055	0.55
2017	0.049	0.75	0.031	0.48	0.068	0.69
2018	0.039	0.63	0.034	0.55	0.071	0.74
2019	0.043	0.71	0.035	0.57	0.058	0.61
2020	0.037	0.64	0.023	0.40	0.054	0.58

5. Predicting the change in demand for agricultural land in 2030

The area and production of strategic crops groups were projected at the level of the Republic in 2030. In order to predict pressure on agricultural lands; it is necessary to predict the population census and the average per capita share to calculate self-sufficiency rates and the minimum of cultivated land per capita [17].

The population was predicted by the following [12]:

$$P_n = P_0(1+R)^n$$

P_0 is the population number in base year; is Years number; and is grows population rate (2.4%) [9]. It is taken into consideration that the expected total consumption will increase as a result of two main factors, the first is population growth, as the study assumed that population growth by 2.4% annually until 2030, the second is an increase in consumption as a result of the change in income, as this increase is determined in the light of income elasticity. The growth rate in total consumption is calculated as follows:

$$R_c = R_p + \varepsilon R_{ri}$$

Where, R_c is growth rate of consumption [18] ; R_p is Population growth rate; ε is Spending elasticity; and R_{ri} is Growth rate of real per capita income.

According to the previous equation, the population is expected to reach 127,530 thousand, with a growth rate of 2.4%. In addition to forecasting the area, production, cultivated area, and cropped area are using moving averages [19]. In addition to forecasting the area, production, cultivated area, and cropped area is using moving averages in the exponential smoothing. Table 10 shows that minimum cultivated land per capita S_{min} equals actual $c_j$cultivated land area per capita S_a At the level of country which expected reach about 0.09, .03, .09 feddan for grain crops group, legume crops group, and oil crops group Respectively. Thus, the pressure Index reaches 1 for grain crops and legume crops that means the ability of cultivated land to meet future rates and be self-sufficient. Finally, expected to increase area of crops group; grain crops (9799 thousand feddan), oil crops (298 thousand feddan), and legume crops (230 thousand feddan) to meeting future needed.

Table 10: Predicting the change in demand for cultivated land in 2030

Issue	Grain Crops Group	Oil Crops Group	legume Crops Group
per capita consumption average (Kg/people)	360	8.2	9.2
Self-sufficiency (%)	70.49	15.62	30
Area of crops group (1000/feddan)	9799	298	230
Area devoted to crop production	50.45	1.5	1.18
Cropping density	1.75	1.75	1.75
Unit Productivity	3.3	1.5	1.38
Minimum cultivated land per capita	0.09	0.03	0.09
actual cultivated land area per capita	0.09	0.09	0.09
Pressure Index	1.00	0.34	1.00

6. Conclusions and Recommendations: The research provides more insights into the relationships between cultivated land and food security for the most important strategic crops groups (grain crops, oil crops, and legume crops), during the period (2000-2020) and the futuristic 2030. Using dependence rate, the quantity of surplus in domestic consumption, period of the sufficiency of production for consumption, the volume of strategic stocks, stock Sufficiency period for daily consumption, food security coefficient as well as cultivated land area, Self-sufficiency, and other factors, which effect on the cultivated land pressure index. The results showed the following:

- The results showed that the average food security coefficient for grain crops, legume crops and oil crops is about 0.032, 0.146 and 0.034, respectively. The decrease in the value of the food security coefficient of this crop is due to the dependence on imports to meet the required needs, in addition to the decrease in the strategic stock. Therefore, it becomes necessary to increase the value of the food security coefficient until it reaches about 0.5 in order to increase the size of the strategic stock to suffice the local consumption of the population, according to food security considerations, through the adoption of several policies and executive programs**.**
- The cultivated land pressure index for grain crops, oil crops, and legume crops is less than 1 during (2000 - 2020) at old and new lands in Egypt, this means the actual cultivated land per capita is greater than minimum cultivated land per capita and is not reached alarm value. This indicates the old lands are still able to achieve self-sufficiency also possible to expand in the new lands to increase the self-sufficiency percentages of strategic crops groups.

- In 2030, the Self-sufficiency ratio is expected to reach70.94% of the grain crops group, 15.62% of the oil crops group, and about 30% legume crops group.
- It is expected that the pressure Index of cultivated land reaches 1 of grain crops , legume, and 0.3 of oil crops group, which means the ability of cultivated land to meet future rates and be self-sufficient. Finally, expected to increase the area of crops group to about 9.8 million feddan of grain crops, 298 thousand feddan of oil crops, and 230 thousand feddan of legume crops to meet the needs of the future.

To this end, the study recommended that protecting cultivated lands requires preventing encroachment and conducting periodic improvement operations to prevent its deterioration and increase its productivity, on the other hand, the necessity of horizontal expansion to increase the cultivated area of the strategic crops studied especially oil crops in new lands.

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