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Analysis of Global and National Scenario of Tuber Crops Production: Trends and Prospects

Prakash^{1}, D. Jaganathan¹, Sheela Immanuel² and P.S. Sivakumar³*

¹Scientist, ²Principal Scientist and Head and ³Principal Scientist, ICAR-Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram, Kerala-695017

*Corresponding author email: prakashiari@yahoo.com

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ABSTRACT

This paper attempts to explore the status of tuber crops cultivation with regard to area, production and productivity across countries and exports of cassava and sweet potatoes from India. The result indicated that among various tuber crops, potatoes were vastly cultivated and consumed by Europe and Asia. At the same time, cassava and sweet potatoes were generally grown and consumed by Africa and Asia. In India, cassava and sweet potatoes are the most important tuber crops due to their large scale and varied uses. The growth rate analysis showed that the area under cassava (-1.38 percent) and sweet potatoes (-0.70 percent) as a whole showed a declining trend in India due to various agro-climatic conditions and socioeconomic constraints. In the context of climate change and considering the importance of root and tuber crops for food and nutritional security, it would be a smart move to bring more area under tuber crops cultivation to achieve 'self-reliance' and 'Make in India Mission'.

Keywords

Cassava, exports, growth rate, potatoes, root and tuber crops, sweet potatoes.

JEL Codes

E23, Q17, Q18.

INTRODUCTION

Root and tuber crops, namely potatoes, cassava, sweet potatoes, yams and other minor tuber crops are important to agriculture, food security and income for about 2.2 billion people in developing countries. These tuber crops play an inevitable role in fulfilling numerous needs of the people, and thereby significantly contributing to attaining the Sustainable Development Goals (SDGs). Globally tuber crops are grown in an area of 67 million ha with a production of 887 million tonnes in 2017 (FAOSTAT, 2019). Among the tuber crops, potatoes contribute a significant share to the total global production, followed by cassava, sweet potatoes, yams, taro and other roots and tubers. In India, cassava and sweet potatoes are the most important tuber crops due to its large area under cultivation and its varied uses.

Cassava is mainly cultivated in the southern parts of India, particularly in Kerala and Tamil Nadu, which contributes over 92 percent of the total cassava production in the country (Horticulture Statistics Division, 2018). In Tamil Nadu, cassava is mainly used as a raw material for starch and sago factories, whereas in Kerala, cassava is a popular secondary staple food, while sweet potatoes are mainly grown in Odisha, Kerala and West Bengal. Mostly, it is used for human consumption and as a cattle feed to some extent (Prakash et al., 2018; Srinivas and Nedunchezhiyan, 2020). In recent times, cassava and sweet potatoes are facing threats from other crops due to decline in tuber prices, easy availability, access to tasty and convenient foods in the rural areas. Therefore, the objective of this study was to assess the status of tuber crops cultivation with regard to area, production and

productivity across countries and exports of cassava and sweet potatoes from India.

METHODOLOGY

The study was based on secondary data compiled from various sources. Information about the area, production and productivity of root and tuber crops for 2017 across the countries was collected from the Food and Agriculture Organization of the United Nations website (FAOSTAT, 2019). The data on area, production and productivity of cassava and sweet potatoes in India for the period of 2001-02 to 2017-18 and also the state-wise area, production and productivity of cassava and sweet potatoes for 2017-18 were collected from the Department of Agriculture, Cooperation and Farmers Welfare website. Information regarding the country-wise export of cassava during 2016-17 to 2018-19 and sweet potatoes during 2011-12 to 2018-19 from India was collected from APEDA website (APEDA, 2019). The data on area, production and productivity of other tuber crops such as yams, taro and Chinese potato, etc. in India are not reported on the website. The descriptive analysis and compound annual growth rate were employed by the following equation (Sendhil et al., 2018; Prakash, Kumar, Kar, Singh & Anbukkani, 2019)

$$Y_t = Y_0(1+r)^t \dots (1)$$

Equation (1) was estimated after transforming it to logarithmic form on both sides as follows

$$\ln Y_t = \ln Y_0 + t \ln(1+r) \dots (2)$$

Where Y_t is the dependent variable (area, production and productivity of cassava and sweet potatoes) for which growth rate is to be estimated at the time of t , Y_0 is the constant and r is the compound annual growth rate. The equation (2) was estimated using the OLS method, and the growth rate was interpreted in terms of percent.

RESULTS AND DISCUSSION

Global Status of Tuber Crops Cultivation

Area, production and productivity of tuber crops

The area, production and productivity of tuber crops in the world are presented in Table 1. Tuber crops are grown in an area of 67 million ha with a production of 887 million tons and having average productivity of 11 t/ha. Among the tuber crops, cassava is the most important tropical tuber crop and also a staple food crop in many of the African countries. Potatoes accounted for about 44 percent of the overall root and tuber crop production in the world, followed by cassava (32.91percent), sweet potatoes (12.72 percent), yams (8.23 percent) and aroids (2.4 percent). Though potatoes lead in the production among the tuber crops, cassava holds the top spot in the area under cultivation. Besides area and production, potatoes (20.1 t/ha) and sweet potatoes (12.26 t/ha) witnessed the highest productivity among the tuber crops.

Continent wise area, production and productivity of tuber crops

Among various tuber crops, cassava, potatoes, and sweet potatoes occupied the major area under cultivation (Table 2). The area under cassava was highest in Africa (76.82 percent), followed by Asia (14.85 percent) with a production share of 60.94 and 29.37 percent, respectively (Table 2 & 3). In the case of potatoes, Asia occupied the first position with an area and production of 53 and 50 percent respectively, followed by Europe (27.79 and 31.37 percent). Even though area and production under potatoes were highest in Asia and Europe, its productivity was maximum in Oceania (41 t/ha), which was higher than the world average (Table 4). Even though Asia leads in the production of sweet potatoes (70.55 percent), Africa (51.24 percent) was ahead of Asia (43.17) in the case of the area under its cultivation (Table 2 & 3). Despite having a maximum area under sweet potatoes cultivation, Africa's production was low due to low productivity (5.88 t/ha) which was lower than the world average (FAOSTAT, 2019).

Table 1. Area, production and productivity of tuber crops in the world during 2017

Crops	Area		Production		Productivity (t/ha)
	Mha	Percent	Mt	Percent	
Cassava	26.34	39.34	291.99	32.91	11.08
Potatoes	19.30	28.82	388.19	43.75	20.11
Sweet potatoes	9.20	13.74	112.84	12.72	12.26
Taro	1.72	2.57	10.22	1.15	5.93
Yams	8.56	12.78	73.02	8.23	8.53
Tannia	0.04	0.06	0.45	0.05	11.25
Other roots and tubers	1.80	2.68	10.64	1.20	5.93
Total	66.97	100	887.35	100	10.79

Source: Authors calculations based on FAOSTAT (FAO, 2019).

Mha: Million hectare; Mt: Million tonnes.

Area, production and productivity of tuber crops by different growing countries

Cassava is an important staple food crop for more than 500 million people in the world due to its high carbohydrate content (Blagbrough, Bayoumi, Rowan & Beeching, 2010). Cassava had an area of 26342 thousand ha with a production of 291992 thousand tons with average productivity of 11.08 t/ha (Table 5). It is grown in 103 countries in the world. Among the continents, African continent holds the first position in terms of area (76.82 percent) and production (60.94 percent) of cassava with a yield of 8.79 t/ha, while the Asian continent occupied the

second position contributing 14.85 percent of the cassava area with a production shares of 29.37 percent in total world cassava production. America continent had 8.26 percent of the cassava area with a production share of 9.60 percent of the world production (third rank). Among the countries, Nigeria had the largest area under cassava (25.78 percent) with an annual output of 20.37 per cent. The Democratic Republic of the Congo occupied the second position in the cassava area, producing 10.82 percent of the world production. Thailand occupied the third position in terms of area (5.10 percent) and production (10.61 percent) of cassava in the world.

Table 2. The continent-wise area under tuber crops during 2017

Continent	(Million ha)						
	Cassava	Potatoes	Sweet potatoes	Taro	Yams	Tannia	Other roots and tubers
World	26.34 (100)	19.30 (100)	9.20 (100)	1.72 (100)	8.56 (100)	0.04 (100)	1.80 (100)
Asia	3.91 (14.85)	10.21 (52.89)	3.97 (43.17)	0.14 (7.87)	0.01 (0.11)	-	0.18 (10.15)
Africa	20.24 (76.82)	1.89 (9.81)	4.72 (51.24)	1.53 (88.79)	8.36 (97.60)	-	1.44 (80.31)
America	2.18 (8.26)	1.80 (9.31)	0.35 (3.78)	0.01 (0.44)	0.16 (1.85)	0.04 (100)	0.13 (7.16)
Europe	-	5.37 (27.79)	0.01 (0.04)	-	-	-	0.01 (0.42)
Oceania	0.02 (0.08)	0.04 (0.20)	0.16 (1.77)	0.05 (2.91)	0.04 (0.44)	-	0.04 (1.95)

Source: Authors calculations based on FAOSTAT (FAO, 2019); Figures in parentheses are percentage to the world area.

Table 3. Continent wise production of tuber crops during 2017

Continent	(Million tonnes)						
	Cassava	Potatoes	Sweet potatoes	Taro	Yams	Tannia	Other roots and tubers
World	291.99 (100)	388.19 (100)	112.84 (100)	10.22 (100)	73.02 (100)	0.45 (100)	10.64 (100)
Asia	85.76 (29.37)	195.67 (50.41)	79.60 (70.55)	2.27 (22.24)	0.16 (0.22)	-	1.64 (15.38)
Africa	177.95 (60.94)	25.01 (6.44)	27.72 (24.57)	7.47 (73.04)	70.98 (97.21)	-	7.59 (71.27)
America	28.04 (9.60)	44.17 (11.38)	4.51 (3.99)	0.07 (0.71)	1.45 (1.98)	0.45 (100)	0.92 (8.63)
Europe	-	121.76 (31.37)	0.09 (0.08)	-	-	-	0.07 (0.62)
Oceania	0.24 (0.08)	1.58 (0.41)	0.92 (0.82)	0.41 (4.00)	0.43 (0.59)	-	0.44 (4.11)

Source: Authors calculations based on FAOSTAT (FAO, 2019). Figures in parentheses are percentage to world production.

Thailand, Indonesia, Vietnam, Cambodia and China mainland are the major cassava producing countries in Asia. India ranked fourth as far as productivity (20.96 t/ha) was concerned as against the world average of 11.08 t/ha of cassava in the world (FAOSTAT, 2019).

Sweet potatoes are the seventh most important food crop, and it is grown in tropical, subtropical and warm temperate regions in the world (Scott, 1992; Low, Nyongesa, Quinn & Parker, 2015). Sweet potatoes are grown in an area of 9202 thousand ha producing 112835

Table 4. Continent wise productivity of tuber crops during 2017

Continent	Cassava	Potatoes	Sweet potatoes	Taro	Yams	Tannia	Other roots and tubers
World	11.08	20.11	12.26	5.93	8.53	11.70	5.93
Asia	21.93	19.17	20.03	16.76	17.46	-	8.98
Africa	8.79	13.22	5.88	4.88	8.50	-	5.26
America	12.89	24.58	12.95	9.66	9.16	11.70	7.14
Europe	-	22.70	24.75	-	17.61	-	8.65
Oceania	11.90	41.08	5.66	8.16	11.42	-	12.48

Source: Authors calculations based on FAOSTAT (FAO, 2019).

Table 5. Area, production and productivity of cassava in the world (2017)

Continent	Country	Area ('000 ha)	Percent of total	Production ('000 t)	Percent of total	Yield (t/ha)
World	Total world	26342.33	100	291992.65	100	11.08
Asia	Total	3911.11	14.85	85762.60	29.37	21.93
	Thailand	1342.40	34.32	30973.29	36.12	23.07
	Indonesia	779.00	19.92	19046.00	22.21	24.45
	Vietnam	532.50	13.62	10267.57	11.97	19.28
	Cambodia	392.07	10.02	10577.81	12.33	26.98
	China mainland	293.69	7.51	4847.10	5.65	16.50
	Philippines	234.54	6.00	2807.67	3.27	11.97
	India	199.00	5.09	4171.00	4.86	20.96
Africa	Total	20235.15	76.82	177947.70	60.94	8.79
	Nigeria	6792.35	33.57	59485.95	33.43	8.76
	DR Congo	3877.94	19.16	31596.05	17.76	8.15
	Uganda	1187.90	5.87	2436.86	1.37	2.05
	Mozambique	1070.38	5.29	8773.71	4.93	8.20
	Angola	1011.62	5.00	11747.94	6.60	11.61
	Ghana	965.51	4.77	18470.76	10.38	19.13
Americans	Total	2175.52	8.26	28037.66	9.60	12.89
	Brazil	1314.85	60.44	18876.47	67.33	14.36
	Colombia	218.45	10.04	2187.76	7.80	10.01
	Paraguay	182.00	8.37	3166.80	11.29	17.40
	Haiti	111.00	5.10	498.03	1.78	4.49
	Peru	98.03	4.51	1196.38	4.27	12.20
Oceania	Total	20.56	0.08	244.69	0.08	11.90
	Papua New Guinea	15.47	75.24	151.30	61.83	9.78
	Fiji	2.73	13.26	66.14	27.03	24.27
	Micronesia	0.97	4.72	10.33	4.22	10.64

Source: Authors calculations based on FAOSTAT (FAO, 2019).

thousand tons with average productivity of 12.16 t/ha (Table 6). It is grown in 119 countries of the world. African continent occupies the first position contributing 51.24 percent of the sweet potatoes area with a production share of 24.57 percent in total world's sweet potatoes production. Even though the sweet potatoes area was more in Africa, its production was low due to low productivity (5.88 t/ha) which was lower than the world average. The Asian continent had second-largest of area (43.17 percent) and first in terms of production (70.55 percent) of sweet potatoes with a yield of 20.03 t/ha. Americans continent had 3.78 per cent of sweet potatoes

area, producing 3.99 per cent (third rank) of the world production. China, the mainland had the largest area under sweet potatoes (36.54 percent) among all the sweet potatoes growing countries in the world with an annual output of 63.64 per cent. Nigeria occupied the second position in sweet potatoes area, producing 3.56 percent of the world production. The United Republic of Tanzania occupied the third and second position in terms of area and production in the world, respectively. China, Indonesia, India and Vietnam were the major sweet potatoes growing countries in Asia.

Taro is grown in an area of 1724 thousand ha

Table 6. Area, production and productivity of sweet potatoes in the world (2017)

Continent	Country	Area ('000 ha)	Percent of total	Production ('000 t)	Percent of total	Yield (t/ha)
World	Total world	9202.78	100	112835.32	100	12.26
Asia	Total	3973.21	43.17	79600.42	70.55	20.03
	China mainland	3362.87	84.64	71796.50	90.20	21.35
	India	128.00	3.22	1460.00	1.83	11.41
	Viet Nam	121.63	3.06	1352.52	1.70	11.12
	Indonesia	113.00	2.84	2023.00	2.54	17.90
	Philippines	84.97	2.14	537.30	0.68	6.32
Africa	Total	4715.30	51.24	27720.78	24.57	5.88
	Nigeria	1619.88	34.35	4013.79	14.48	2.48
	United Republic of Tanzania	800.06	16.97	4244.37	15.31	5.31
	Uganda	391.97	8.31	1656.98	0.04	4.23
	Malawi	271.45	5.76	5472.01	19.74	20.16
	Ethiopia	246.50	5.23	2008.29	7.24	8.15
	Angola	206.73	4.38	1857.80	6.70	8.99
	Rwanda	184.61	3.92	1078.97	3.89	5.84
	Madagascar	139.65	2.96	1140.95	4.12	8.17
Americans	Total	348.09	3.78	4506.83	3.99	12.95
	Haiti	105.00	30.16	630.00	13.98	6.00
	United States of America	64.47	18.52	1616.88	35.88	25.08
	Brazil	53.48	15.36	776.29	17.22	14.52
	Cuba	47.62	13.68	517.62	11.49	10.87
	Argentina	23.60	6.78	342.83	7.61	14.53
	Peru	14.17	4.07	256.43	5.69	18.10
Europe	Total	3.46	0.04	85.65	0.08	24.75
	Spain	2.00	57.79	51.00	59.54	25.50
	Portugal	0.92	26.52	22.87	26.70	24.90
	Italy	0.39	11.21	8.49	9.92	21.89
Oceania	Total	162.72	1.77	921.63	0.82	5.66
	Papua New Guinea	138.44	85.08	713.78	77.45	5.16
	Solomon Islands	7.42	4.56	105.06	11.40	14.16

Source: Authors calculations based on FAOSTAT (FAO, 2019).

producing 10221 thousand tonnes with average productivity of 5.93 t/ha (Table 7). It is grown in 50 countries of the world. African continent occupied the first position with an area and production of taro accounted for 89 and 73 percent of total world's taro production followed by Asia (7.87 and 22.24 percent) and Oceania (2.91 and 4 percent). Even though the taro area and production were more in Africa, but productivity was quite low (4.88 t/ha), which was lower than the world average (5.93 t/ha). Nigeria accounted larger area under taro (48 percent) among all the taro growing countries in the world with an annual output of 31.80 per cent, followed by Cameroon (13.16 percent) and Ghana (10.67 percent). China and Japan were the major taro growing countries in Asia.

Yams are a staple food in West Africa, Southeast Asia and the Caribbean regions (Liu, Shang, Wang, Hsu & Hou, 2007). Yams are grown in an area of 8560 thousand ha producing 73018 thousand tons with average productivity of 8.53 t/ha (Table 8). It is grown in 61 countries of the world. African continent alone accounted for 98 percent of the area under yams with a production share of 97 percent in total world yams production followed by Americans. Nigeria had the largest area under yams (69 percent) among the yams producing countries in the world with an annual output of 66 per cent. CA te

d'Ivoire occupied second position in yams area producing 9.79 percent of the world production. Ghana occupied the third position in terms of area (5.44 percent) and second in terms of production (10.89 percent) in the world.

Table 9 depicted the area, production and productivity of other roots and tubers growing countries in the world. It is grown in an area of 1795 thousand ha producing 10643 thousand tonnes with average productivity of 5.93 t/ha. It is grown in 80 countries of the world. African continent occupied the first position contributing 80.31 percent of the other roots and tubers area with a production share of 71.27 percent in total world's roots and tuber production. The Asian continent was the second-largest in terms of area (10.15 percent) and production (15.388 percent) of other roots and tubers with a yield of 8.98 t/ha. American countries had 7.6 per cent of the area producing 8.63 per cent (third rank) of the world production. Ethiopia had the largest area under other roots and tubers (66 percent) among all the roots and tubers growing countries in the world with an annual output of 53 per cent followed by the Democratic Republic of Congo.

Status of Tuber Crops Cultivation in India

Temporal changes in the area, production and productivity of tuber crops in India

The national-level production details of cassava and

Table 7. Area, production and productivity of taro in the world (2017)

Continent	Country	Area ('000 ha)	Percent of total	Production ('000 t)	Percent to total	Yield (t/ha)
World	Total world	1724.18	100	10221.96	100	5.93
Asia	Total	135.63	7.87	2273.62	22.24	16.76
	China, mainland	95.24	70.22	1865.36	82.04	19.59
	Philippines	15.01	11.07	109.37	4.81	7.29
	Japan	11.94	8.80	150.05	6.60	12.57
	Thailand	10.66	7.86	102.37	4.50	9.60
Africa	Total	1530.84	88.79	7466.47	73.04	4.88
	Nigeria	831.32	54.30	3250.86	43.54	3.91
	Cameroon	226.83	14.82	1847.12	24.74	8.14
	Ghana	183.96	12.02	1200.24	16.08	6.52
Americans	Total	7.52	0.44	72.60	0.71	9.66
	Nicaragua	4.40	58.46	42.57	58.63	9.68
	Dominica	1.25	16.64	12.29	16.93	9.83
	French Guiana	1.14	15.18	4.05	5.58	3.55
Oceania	Total	50.19	2.91	409.27	4.00	8.16
	Papua New Guinea	36.51	72.74	274.39	67.04	7.52
	Samoa	4.60	9.16	24.59	6.01	5.35
	Solomon Islands	2.64	5.26	45.90	11.22	17.39
	American Samoa	2.86	5.71	10.97	2.68	3.83
	Fiji	2.15	4.28	42.99	10.50	20.00

Source: Authors calculations based on FAOSTAT (FAO, 2019).

sweet potatoes are displayed in Table 10. It was observed that the compound annual growth rate of area under cassava (-1.38 percent) and sweet potatoes (-0.70 percent) cultivation showed a negative trend over the years from 2001-02 to 2017-18. Though the area under sweet potatoes cultivation showed a negative trend, an increase in its productivity increased its production growth (1.40 percent) over the years. Prakash, Kishore, Jaganathan, Immanuel and Sivakumar (2018) reported that the decline in annual growth of production under sweet potatoes (-0.87 percent) in India was mainly due to decrease in production acreage (-1.88 per cent). However, the productivity of sweet potatoes consistently increased from 7.03 tons per ha in 1981-82 to 11.76 tons per ha in 2016-17 (1.02 percent). On the contrary, in the case of cassava, the reduction in the area as well as productivity, there was a decline in the growth of production of cassava over the years. Edison, Anantharaman & Srinivas (2006) reported that the total area under cassava cultivation in India showed a declining trend. However, the positive growth in its productivity of cassava helped its positive and non-significant growth in its production despite the

significant decline in the area over the years from 1867-68 to 2001-02.

The state-wise production details of cassava for 2017-2018 are depicted in Table 11. Area (89.61 thousand ha) and production (2862 thousand tons) of cassava were highest in Tamil Nadu followed by Kerala (54.73 thousand ha and 1725 thousand tons). Tamil Nadu alone contributed nearly 58 percent of the total cassava produced in the country. The productivity of cassava was also highest in Tamil Nadu (31.94 t/ha) which was more than the national average (28.64 t/ha). Apart from South Indian states, some of the North-Eastern states such as Nagaland (1.60 percent), Assam (0.58 percent) and Meghalaya (0.73 percent) also provided a considerable share in total cassava production during 2017-18.

The total area under sweet potatoes cultivation in India was about 130.6 thousand hectares during 2017-18 with a production of about 1500 thousand tons (Table 12). Among the states, Odisha had the highest share of area under sweet potatoes cultivation (30.94 percent), followed by Kerala (15.98 percent), West Bengal (15.62 percent) and Uttar Pradesh (13.25 percent). Though the

Table 8. Area, production and productivity of yams in the world (2017)

Continent	Country	Area ('000 ha)	Percent to total	Production ('000 t)	Percent to total	Yield (t/ha)
World	Total world	8560.54	100	73018.87	100	8.53
Asia	Total Asia	9.13	0.11	159.33	0.22	17.46
	Japan	6.67	73.07	144.95	90.98	21.74
	Philippines	2.46	26.93	14.38	9.02	5.85
Africa	Total Africa	8355.47	97.60	70979.37	97.21	8.50
	Nigeria	5924.91	70.91	47942.71	67.54	8.09
	Côte d'Ivoire	1239.25	14.83	7148.00	10.07	5.77
	Ghana	465.91	5.58	7952.75	11.20	17.07
	Benin	212.20	2.54	3133.37	4.41	14.77
Americans	Total Americans	158.20	1.85	1448.33	1.98	9.16
	Haiti	55.45	35.05	439.33	30.33	7.92
	Colombia	42.73	27.01	422.06	29.14	9.88
	Brazil	25.80	16.31	250.40	17.29	9.71
	Cuba	9.32	5.89	52.88	3.65	5.67
	Jamaica	8.76	5.54	144.32	9.96	16.47
Europe	Total Europe	0.14	0.00	2.38	0.00	17.61
	Portugal	0.14	100	2.38	100	17.61
Oceania	Total Oceania	37.61	0.44	429.48	0.59	11.42
	Papua New Guinea	20.56	54.67	362.67	84.45	17.64
	Fiji	7.34	19.51	4.43	1.03	0.60
	Solomon Islands	4.29	11.40	44.94	10.46	10.48
	New Caledonia	2.73	7.27	2.37	0.55	0.87

Source: Authors calculations based on FAOSTAT (FAO, 2019).

Table 9. Area, production and productivity of other roots and tubers in the world (2017)

Continent	Country	Area ('000 ha)	Percent to total	Production ('000 t)	Percent to total	Yield (t/ha)
World	Total world	1795.63	100	10643.77	100	5.93
Asia	Total	182.29	10.15	1637.01	15.38	8.98
	Indonesia	69.33	38.03	414.76	25.34	5.98
	Nepal	33.31	18.27	171.32	10.47	5.14
	Pakistan	32.93	18.07	523.39	31.97	15.89
	Thailand	18.07	9.91	294.71	18.00	16.31
Africa	Total	1442.12	80.31	7585.78	71.27	5.26
	Ethiopia	1177.41	81.64	5648.31	74.46	4.80
	DR Congo	140.81	9.76	1029.44	13.57	7.31
	Namibia	43.10	2.99	368.64	4.86	8.55
Americans	Total	128.62	7.16	918.14	8.63	7.14
	Peru	37.82	29.41	273.06	29.74	7.22
	Haiti	24.58	19.11	59.57	6.49	2.42
	Bolivia	16.12	12.54	47.03	5.12	2.92
	Colombia	16.09	12.51	133.83	14.58	8.32
	Ecuador	11.44	8.89	30.45	3.32	2.66
	Mexico	7.30	5.67	216.51	23.58	29.67
Europe	Total	7.57	0.42	65.49	0.62	8.65
	France	5.98	78.96	35.70	54.51	5.97
	Slovenia	0.90	11.88	16.00	24.43	17.78
	Spain	0.40	5.33	7.34	11.21	18.17
Oceania	Total	35.04	1.95	437.36	4.11	12.48
	Papua New Guinea	24.37	69.55	355.25	81.23	14.58
	Vanuatu	6.43	18.35	52.80	12.07	8.21

Source: Authors calculations based on FAOSTAT (FAO, 2019).

Table 10. The trend in the area, production and productivity of cassava and sweet potatoes in India

Year	Cassava			Sweet potatoes		
	Area	Production	Productivity	Area ('000 ha)	Production	Productivity
2001-02	238.9	6515.9	27.3	131.9	1130.3	8.6
2002-03	207.0	5426.2	26.2	131.9	1130.3	8.6
2003-04	220.0	5949.6	27.0	133.1	1179.1	8.9
2004-05	244.7	7462.8	30.5	133.3	1179.4	8.8
2005-06	244.6	7854.9	32.1	122.8	1066.5	8.7
2006-07	255.0	8232.0	32.3	123.0	1067.2	8.7
2007-08	270.0	9056.0	33.5	123.0	1094.0	8.9
2008-09	280.0	9623.0	34.4	124.0	1120.0	9.0
2009-10	231.9	8059.9	34.8	118.9	1094.7	9.2
2010-11	221.0	8076	36.5	113.0	1047.0	9.3
2011-12	226.7	8746.5	38.6	110.4	1072.8	9.7
2012-13	207.0	7236.6	35.0	111.8	1132.4	10.1
2013-14	228.0	8139.0	35.7	106.0	1088.0	10.3
2014-15	208.0	4372.7	21.0	106.9	1227.8	11.4
2015-16	203.5	4344.2	21.3	126.4	1454.3	11.5
2016-17	198.7	4170.8	21.0	128.4	1460.2	11.4
2017-18	172.8	4949.6	28.6	130.6	1500.5	11.5
CAGR (2001-02-2017-18)	-1.38	-2.20	-0.84	-0.70	1.40	2.09

Source: Authors calculation based on Horticulture Statistics at a Glance, GoI, 2018.

Note: CAGR=Compound annual growth rate.

area under cultivation of sweet potatoes in Kerala was less than half of that in Odisha, it produced nearly 23 per cent of the total sweet potatoes produced in the country, whereas, Odisha contributed only 25 percent to the total production. Interestingly, productivity was highest in Andhra Pradesh (17 t/ha). It had only 1.71 percent of the area under sweet potatoes cultivation but contributed 2.49 percent to the total production. The average productivity of sweet potatoes in Karnataka and Odisha were estimated to be 9.83 and 10.66 tons per ha respectively which was less than the national average reported by Prakash, Kishore, Roy, Behura and Immanuel (2017); Prakash et al., (2018).

Status of export of tuber crops in the country

Table 13 showed the country-wise export of cassava during 2016-17 to 2018-19 from India. Asia-Pacific (APAC) is the largest market and second-largest producer of cassava products. China is the world largest importer of cassava products, mainly cassava chips and cassava flour. Thailand and Vietnam are the largest exporters of cassava globally. It was estimated that the production of cassava in Asia increased by 12.8 percent compared to the production in 2013. India also one of the importers of cassava and producers of cassava. Cassava is mainly used as a raw material for starch and sago factories and also used for culinary purpose. About 24 per cent of cassava

Table 11. State-wise area, production and productivity of cassava in India during 2017-18

States/UTs	Area ('000 ha)	Production ('000 t)	Productivity (t/ha)	Percent of share of area	Percent of share of production
Tamil Nadu	89.61	2862.14	31.94	51.85	57.83
Kerala	54.73	1725.98	31.54	31.67	34.87
Andhra Pradesh	12.68	192.15	15.15	7.34	3.88
Nagaland	5.47	79.32	14.50	3.17	1.60
Assam	3.12	28.87	9.25	1.81	0.58
Meghalaya	5.49	36.24	6.60	3.18	0.73
Karnataka	1.08	13.99	12.95	0.62	0.28
Madhya Pradesh	0.28	4.29	15.32	0.16	0.09
Other states	0.37	6.65	13.13	0.21	0.13
India	172.82	4949.62	28.64	100	100

Source: Authors calculation based on Horticultural Statistics at a Glance, GoI, 2018.

Table 12. State-wise area, production and productivity of sweet potatoes in India during 2017-18

States/UTs	Area ('000 ha)	Production ('000 t)	Productivity (t/ha)	Percent of share of area	Percent of share of production
Assam	5.3	29.2	5.51	4.06	1.95
Bihar	1.04	8.51	8.18	0.80	0.57
Chhattisgarh	4.29	45.04	10.50	3.28	3.00
Karnataka	2.71	34.8	12.84	2.08	2.32
Madhya Pradesh	5.19	78.87	15.20	3.97	5.26
Meghalaya	4.75	15.97	3.36	3.64	1.06
Odisha	40.41	381.04	9.43	30.94	25.39
Uttar Pradesh	17.33	229.59	13.25	13.27	15.30
West Bengal	20.4	220.44	10.81	15.62	14.69
Kerala	20.87	341.02	16.34	15.98	22.73
Andhra Pradesh	2.23	37.32	16.74	1.71	2.49
Maharashtra	3.51	43.26	12.32	2.69	2.88
Other states	2.59	35.45	11.05	1.98	2.36
India	130.6	1500.51	11.49	100	100

Source: Authors calculation based on Horticultural Statistics at a Glance, GoI, 2018.

Table 13. Country-wise export of cassava and substitutes during 2016-17 to 2018-19 from India

Country	2016-17	2017-18	2018-19	(Tonnes)	
				Percent share in 2018-19	Percent growth on the previous year
United Arab Emirates	467.57	597.17	774.36	23.89	25.69
United States	65.26	162.97	246.24	13.22	33.02
Oman	347.48	357.29	367.06	11.77	4.6
Saudi Arab	299.53	536.09	349.91	11.53	-34.4
Nepal	138.55	208.68	222.63	8.02	-14.19
United Kingdom	76.52	187.9	126.21	6.46	-46.85
Australia	42.09	91.53	84.63	4.33	-1.78
Kuwait	4.11	148.2	101.71	3.77	-33.17
Qatar	26.21	63.78	112.72	3.73	60.87
Bangladesh	0	21	142	3.16	527.23
Canada	11.32	30.55	41.99	2.56	18.86
New Zealand	18.6	11.4	23.96	1.3	68.08
Other countries	53.76	113.44	134.58	4.93	18.64
Total	1551	2530	2728	100	-0.16

Source: Authors calculations based on apeda.gov.in

Table 14. Country-wise export of sweet potatoes (tons) during 2011-12 to 2018-19 from India

Year	UAE	Nepal	Maldives	Bahrain	Other countries	Total
2011-12	828	19	91	4	68	1010
2012-13	536	54	20	18	5	632
2013-14	276	149	45	6	25	502
2014-15	344	8	44	6	25	427
2015-16	294	88	120	4	3	509
2016-17	246	127	59	0	2	434
2017-18	160	131	85	4	24	404
2018-19	107	507	67	3	9	693
Percent of share in 2018-19	15.44	73.16	9.67	0.43	1.30	100
Percent of growth on previous year	-33.13	287.02	-21.18	-25.00	-62.50	71.53

Source: Authors calculations based on apeda.gov.in.

was exported to the United Arab Emirates followed by USA (13 percent) and Oman (12 percent).

The country-wise export of sweet potatoes during 2011-12 to 2018-19 from India are presented in Table 14. About 80 per cent of the sweet potatoes were sold through retail markets in India during 2011-16 and the rest exported to other countries. In 2015-16, the total market size of sweet potatoes for direct consumption was estimated as ₹36.4 billion, with a compound Annual Growth Rate (CAGR) of 13.7 percent during 2011-16 (Euro monitor International, 2017). About 73 percent of sweet potatoes were exported to Nepal followed by United Arab Emirates (15 percent) and Maldives (10 percent) mostly as fresh tubers during 2018-2019.

CONCLUSIONS

Tuber crops are considered as an important nutritional source in ensuring food security of about 2.2 billion people in developing countries across the globe. Among various tuber crops, potatoes are vastly cultivated and consumed by countries in Europe and Asia. At the same time, cassava and sweet potatoes are grown mainly and consumed by developing countries in Africa and Asia. In India, cassava and sweet potatoes are the most important food crops and are extensively cultivated by small and marginal farmers. The area of cassava and sweet potatoes in India as a whole showed a declining trend which may be due to replacement with other commercial crops coupled with other socio-economic

constraints. The importance of root and tuber crops for food and nutritional security is well known due to richness in calories and essential nutrients. Hence, concerted efforts from research institutes, developmental organizations, processing industries and farmers groups are warranted to increase more area under tuber crops cultivation in India and the world to feed the ever-growing population sustainably.

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