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Analysis of Trend in Area, Production and Yield of Major Vegetables of Nepal

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ABSTRACT

Vegetable production is an important sector of economy for farmers in Nepal. The analysis was carried out to explore the trends in vegetable production sector in Nepal along with the recent trend of some major vegetables in terms of area, production and yield. The time series data from 1977/78 to 2016/17 (40 years) of vegetables production and 5 years data (2011/12 - 2015/16) of major vegetables were collected from reliable source and analysis was done through Microsoft Excel. The results show that between 1977/78 and 2016/17 the area under vegetables cultivation has jumped by 222.8% while production is increased by 728.21% and productivity is increased by 156.6% during this course. The result also reveals that during the period of 5 years (2011/12 - 2015/16), solanaceous and cruciferous vegetables has an increasing trend in area, production and yield except for the area under cultivation for eggplant (declined by 5.2%) and for radish (declined by 6.0%) respectively while cucurbitaceous vegetables has increasing trend in area and production but an declining trend in yield except for the yield of cucumber (increased by 15.8%). However, the trend of other major vegetables is seen highly fluctuating over the years.

***Keywords*:** Horticulture; Vegetables; Trend; Nepal

1. Introduction

With 65.1 percentage of people engaged, agriculture contributes 31.23% to National Gross Domestic Product (GDP) where horticulture sub-sector has the most significant role sharing 21.42 percent[1]. Vegetable production alone contributes around 9.71% to total Agricultural GDP[2]. Vegetable farming has been widely adopted by the people across the country as a part of their employment. Vegetable farming in Nepal is not only the mainstay of its economy but also way of life of rural farmers. In the year 2016/17, the total cultivated area of the country is about 3.09 million hectare, among which vegetable crops occupy 9.19 % of total cultivated agricultural land and the annual vegetable production was found to be 38,59,492 metric ton with average productivity of 13.5 Mt/ha[3]. The average productivity of vegetables from 1991/92 to 2015/16 was 11.09 Mt/ha[4].

In terms of export, vegetable is the fifth important agriculture product behind Lentil (29.6% of agricultural exports), cardamom (7%), wheat (6.7%), and tea[5]. In 2015/16, Nepal imported edible vegetables and certain roots and tubers worth NPR 17,958,156,000 and exported them worth NPR 1,606,611,000 with a trade balance of -16,351,545,000[6]. This shows that there is good potential for import replacement in vegetables. Similarly, the demand for vegetables is increasing at higher rate with increasing rate of population. Rising incomes are changing food demand from cereals towards more vegetables and fruits consumption.

It has been of high importance to increase the vegetable production with the limitation of land available for cultivation. Realizing the importance of production potential and increasing demand of vegetables, several programs have been conducted to promote commercial vegetable farming. Agriculture Perspective Plan (APP, 1995-2014) had targeted the growth rate of horticulture GDP to 5.5 percent per annum by 2014/2015 and growth rate of vegetable GDP in particular to 5.42 percent per annum[7]. In order to come up with targeted growth rate of the agriculture, APP mainly emphasized on the production of high value crops through the pocket packages strategy on crops and horticulture crops

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in different areas of different ecological zones. Similarly, under the outcome Profitable Commercialization, ADS has highlighted enhancing development of the vegetables value chain through production, marketing and policy/institutional support as an important activity. The strategy has prioritized a limited number of value chains over the first five years and vegetable sector is one among the top five sectors[8].

However, insufficient study on analysis of the recent trends of vegetable production in the country has constricted the efficient planning and program development in this sector. Thorough observation of the pattern of growth of vegetable sector over time to assess whether it has used the investments efficiently to achieve the maximum/optimum production is important. As the sector plays significant role for the country's economy, it is a foremost requirement to identify the time periods where insufficient growth has been experienced and further study on the respective government policies and programs should be made. The present study was conducted with a view to analyze trends in area, production and yield of vegetables in Nepal over the past 40 years. Further, the study was undertaken to assess the growth pattern in the context of total cultivated area, production and yield followed by some economically important vegetables of the country during the period of five years (2011/12 to 2015/16).

2. Materials and Methodology

The time series secondary data for area, production and productivity for vegetables in hectare, metric ton and kilogram/hectare of total 40 years (from 1977/78 to 2016/17) were extracted from publications of Vegetable Development Directorate and data of major vegetables selected on the basis of family were collected from the data book published by Ministry of Agriculture Development (MoAD) for 5 years period from 2011/12 to 2015/16.

Linear trend analysis model was used to analyze time series data of area, production and productivity of vegetables in Nepal. The statistical analysis of area, production and yield scenario was carried out through Microsoft excel program. Line graphs were prepared using MS Excel to interpret the results. Annual average yield of vegetables was calculated as:

AAY (Annual average yield) of vegetables = (Production of 1977/78+ Production of 1978/79+……+Production of 2016/17)/ (Area of 1977/78+ Area of 1978/79+…….+ Area of 2016/17).

3. Results and Discussion

3.1 Vegetable production trend in Nepal

On analyzing the area, production and yield of overall vegetable sector over past 40 years (1977/78 - 2016/17), the trend of area under cultivation, production and yield of vegetables is increasing over time (Fig. 1). Its cultivation area has jumped by 222.8% between 1977/78 and 2016/17 while production is increased by 728.21% and productivity is increased by 156.6% during this course. The area under cultivation is continuously increasing every year with a varying rate except for the years 1998/99 and 2015/16 where it has decreased than the previous year. Similar is the trend in production scenario of vegetables, which is continuously increasing each year with a varying rate except for the years 1980/81 and 1998/99 where it has decreased than the previous year. Over the years (1977/78 - 2016/17), the yearly average area under vegetables cultivation is 167558.45 ha and the yearly average production is 1705066.25 Mt with a yearly average yield of 10.2 Mt/ha. In **Figure 1**, the R square value for the production and area trend line is 0.924 and 0.880 respectively which are closer to 1. This signifies that the trend line is more accurate to the data.

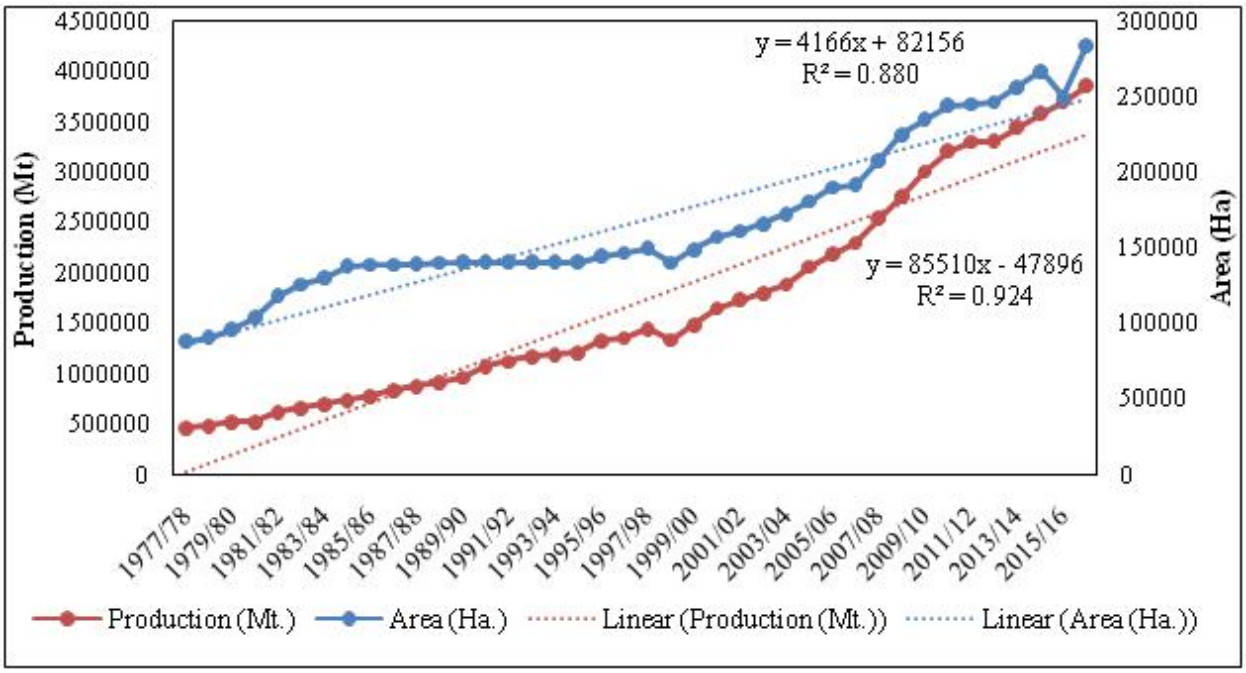

Figure 1; Vegetable production trend in Nepal**.**

(Source: Vegetable Development Directorate 2014/15 and MoAD 2017/18)

3.2 Production trend of Major Vegetables of Nepal (2011/12 - 2015/16)

3.2.1 Solanaceous vegetables

Among the different solanaceous vegetables grown in Nepal, tomato, eggplant, chilli and capsicum are the major ones and are considered under the study. In the year 2015/16, this group shares 15.8% of total area (39491 ha) and 16.8% of total production (623154.6 Mt) of vegetables in the country whereby tomato has the highest share of 8.0 percent in area under cultivation (20046 ha) and 10.5 percent in total vegetables production of the country (386824.6 Mt). During the period of 5 years (2011/12 - 2015/16), each vegetables of this family has an increasing trend in area, production and yield except for the area under cultivation for eggplant which has declined by 5.2% (Fig. 2,3,4).

The area under cultivation of solanaceous vegetables is moreover increasing every year with a varying rate except for; tomato in 2013/14 where it has declined by 12.4% than the previous year, eggplant and chilli in 2013/14 with decline percentage of 10.0 and 13.9 respectively, capsicum in the year 2014/15 with decline percentage of 15.5 and eggplant in the year 2015/16 with decline percentage of 6.0. Similar is the trend in production scenario, which is increasing each year with a varying rate except for; chilli in 2012/13 (declined by 3.9 % than the previous year), tomato and eggplant in 2013/14 with decline percentage of 22 and 4.1 respectively, capsicum in 2014/15 with decline percentage of 19 and eggplant in 2015/16 with decline percentage of 2.6.

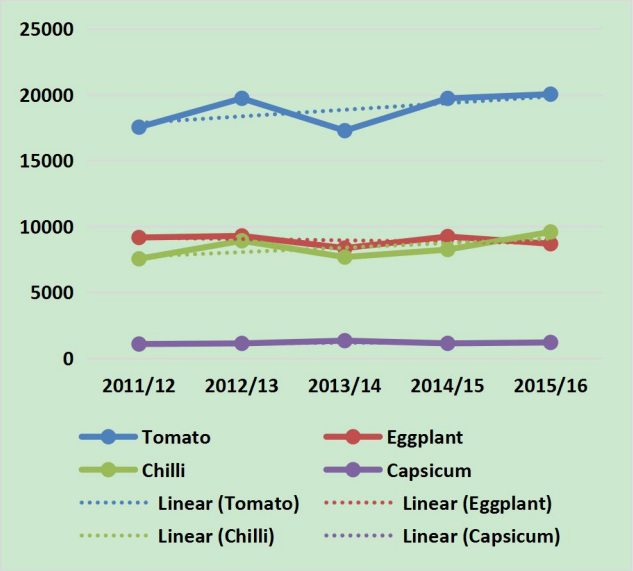

Figure 2; Trend in area cultivated for major solanaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

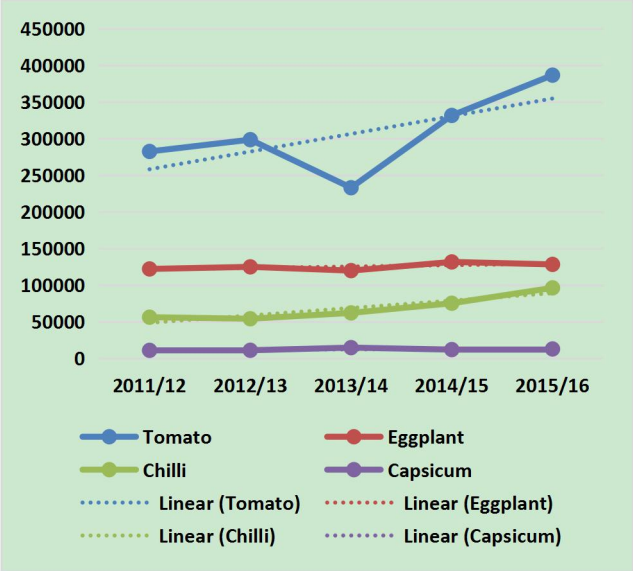

Figure 3; Trend in production of major solanaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

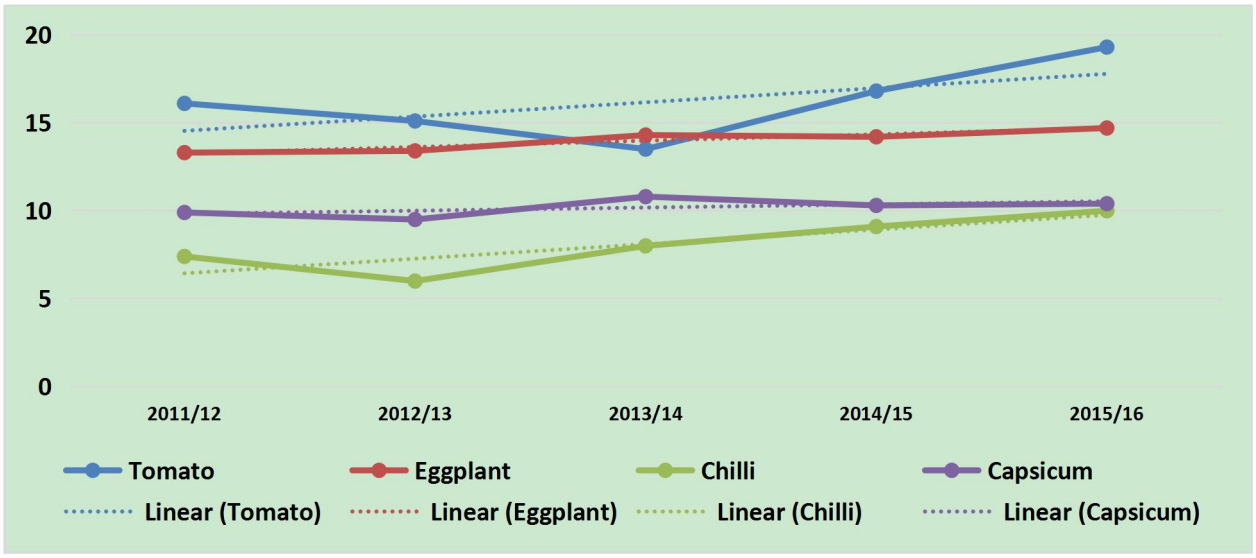

Figure 4; Trend in yield of major solanaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

The trend in yield of the solanaceous vegetables shows that the yield for tomato has decreased in the years 2012/13 and 2013/14 (by 6.0 % and 10.9 % than the previous year respectively) and increased thereafter by 24.7% and 14.7% in 2014/15 and 2015/16 respectively with an overall rise by 19.8% since 2011/12 to 2015/16. There has been a decline in yield of chilli and capsicum in 2012/13 and decline in yield of eggplant and capsicum in 2014/15 while the yield is in increasing trend in other years.

3.2.2 Cruciferous vegetables

Among the different cruciferous vegetables grown in Nepal, cauliflower, cabbage and radish are the major ones and are considered under the study. In the year 2015/16, this group shares 32% of total area (79954.1 ha) and 35.1% of total production (3700969 Mt) of vegetables in the country whereby cauliflower has the highest share of 14.0 percent in area under cultivation (34967 ha) and 14.9 percent in total vegetables production of the country (550044.8 Mt), which is the highest among all the vegetables. During the period of 5 years (2011/12 - 2015/16), each vegetables of this family has an increasing trend in area, production and yield except for the area under cultivation for radish which has

declined by 6.0% (Fig. 5,6,7).

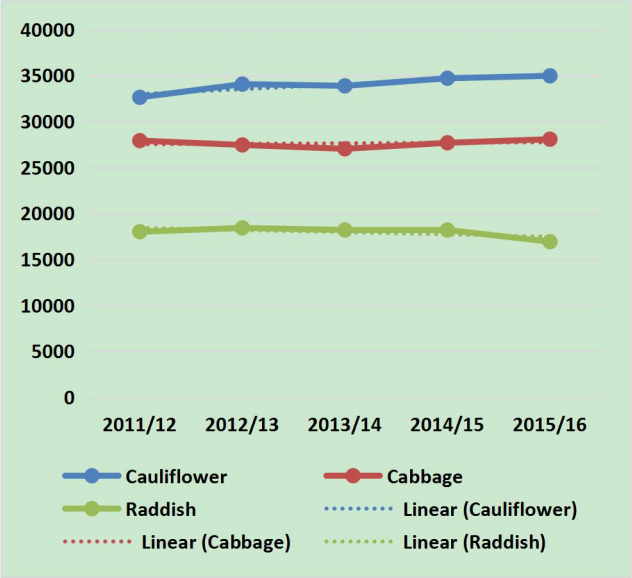

Figure 5; Trend in area cultivated for major cruciferous vegetables (2011/12–2015/16)**.**

(Source: MoAD 2011/12 to 2015/16)

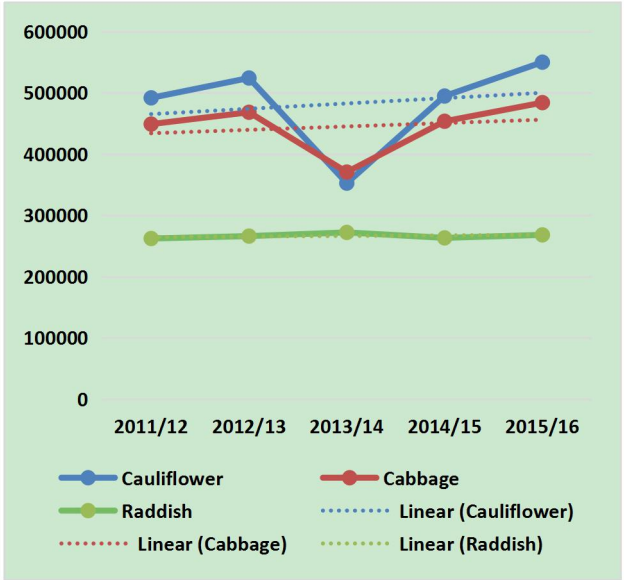

Figure 6; Trend in production of major cruciferous vegetables (2011/12–2015/16)**.**

(Source: MoAD 2011/12 to 2015/16)

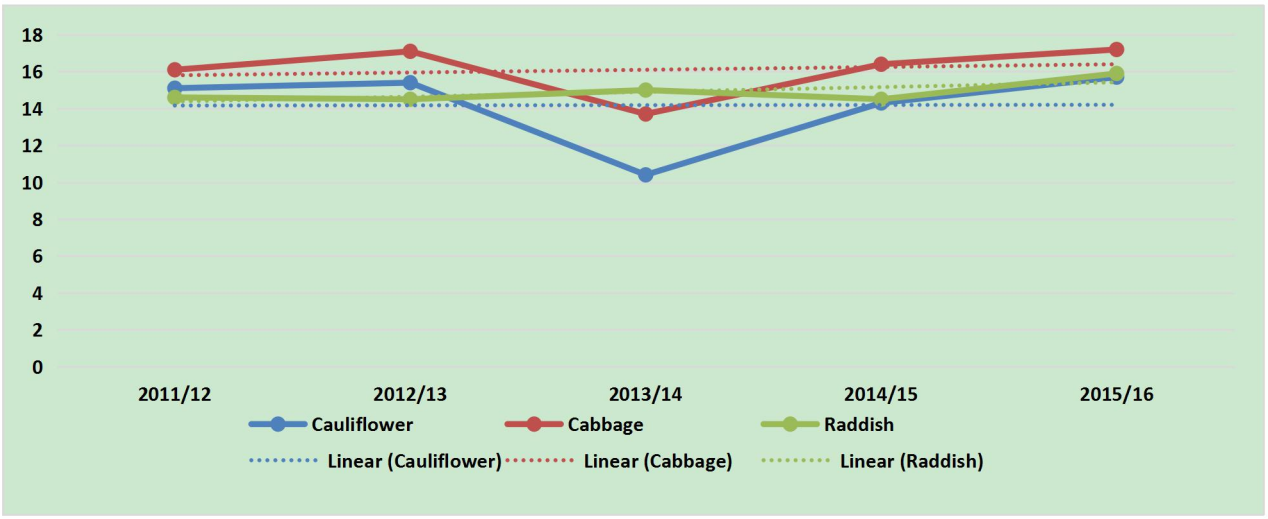

Figure 7; Trend in yield of major cruciferous vegetables (2011/12–2015/16)**.**

(Source: MoAD 2011/12 to 2015/16)

There has been decline in production of cruciferous vegetables (32.7% in cauliflower and 20.8% in cabbage) in the year 2013/14 along with decline in area under cultivation (0.5% in cauliflower and 1.5% in cabbage) and decline in yield (32.4% in cauliflower and 19.6% in cabbage). However, the area, production and yield of cauliflower and cabbage have increased in the recent years. The area under cultivation for radish has declined from 18415 ha in 2012/13 to 16915.7 ha in 2015/16 while the production and yield are increasing except for the year 2014/15 where there is a decline of 3.3% in both production and yield.

3.2.3 Cucurbitaceous vegetables

Among the different cucurbitaceous vegetables grown in Nepal, bottle gourd, bitter gourd, cucumber, and pumpkin are the major ones and are considered under the study. In the year 2015/16, this group shares 14.1% of total area (35293.9 ha) and 14.16% of total production of vegetables in the country (524359.6 Mt) whereby bitter gourd has the

highest share of 4.0 percent in area under cultivation (10082.2 ha) and cucumber has the highest share of 4.3 percent in total vegetables production of the country (159041.8 Mt). On analysing recent 5 years (2011/12 - 2015/16) trend of major cucurbitaceous vegetables, each vegetable has an increasing trend in area and production while there is an declining trend in yield of all vegetables except for the yield of cucumber which was increased by 15.8% (Fig. 8,9,10).

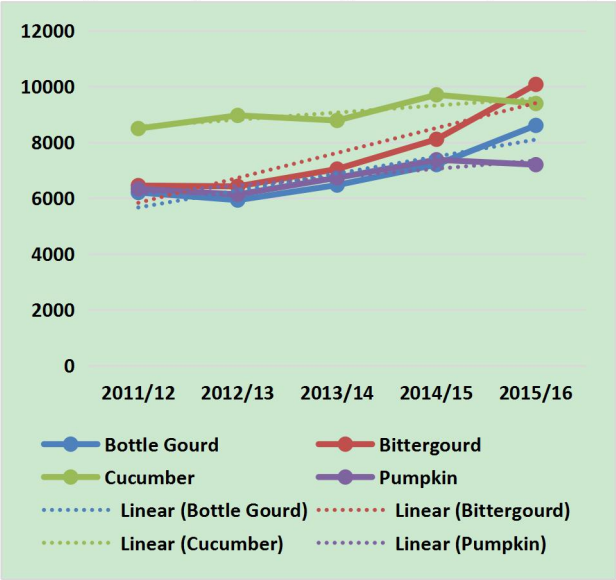

Figure 8; Trend in area cultivated for major cucurbitaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

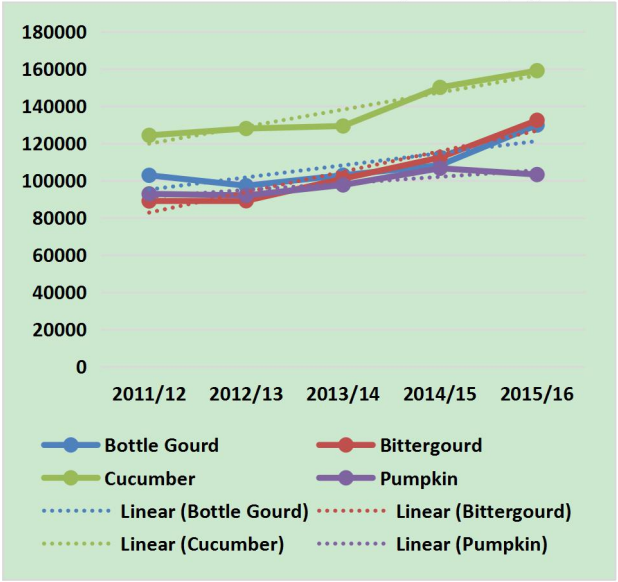

Figure 9; Trend in production of major cucurbitaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

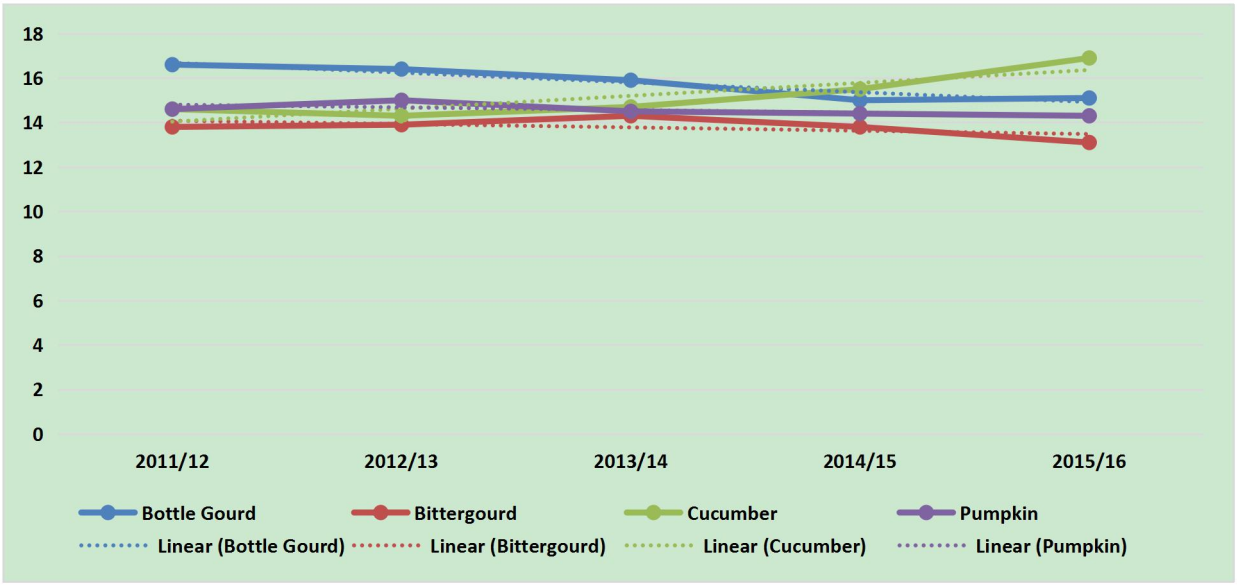

Figure 10; Trend in yield of major cucurbitaceous vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

The area under cultivation of cucurbitaceous vegetables is moreover increasing every year with a varying rate, except during the year of 2012/13 where area for bottle gourd, bitter gourd and pumpkin has declined by the percentage of 4.4, 0.4 and 3.2 respectively. The area under pumpkin cultivation for the year 2015/16 declined with the percentage of 2.4. Similarly, cucumber cultivation area declined in the year 2013/14 and 2015/16 by 2 and 3.2 percentages respectively. Similar is the trend in production scenario, which is increasing every year with a varying rate, except during the year 2012/13 where production for bottle gourd and pumpkin is declining with 5.4 and 0.9 percentage. In 2015/16, the production of pumpkin decreased by 3.2 percentage than previous year.

The trend in yield of the cucurbitaceous vegetables shows that the yields for all the crops are declining. But in the year of 2015/16 the yield of bottle gourd increased by only 0.4 percentage. In the year of 2012/13 the yield of bitter gourd and pumpkin was increased by 0.6 and 2.4 percentage respectively, whereas for cucumber the yield is increased in every year except in 2012/13 with declining percentage of 2.5.

3.2.4 Other vegetables

Based on the higher percentage share in area and production, major vegetables of family Amaryllidaceae (onion, garlic), Leguminosae (cowpea, French bean) and okra from family Malvaceae are included under study as other vegetables. On analyzing 5 years (2011/12 - 2015/16) trend of above vegetables, each vegetables trend is seen highly fluctuating.

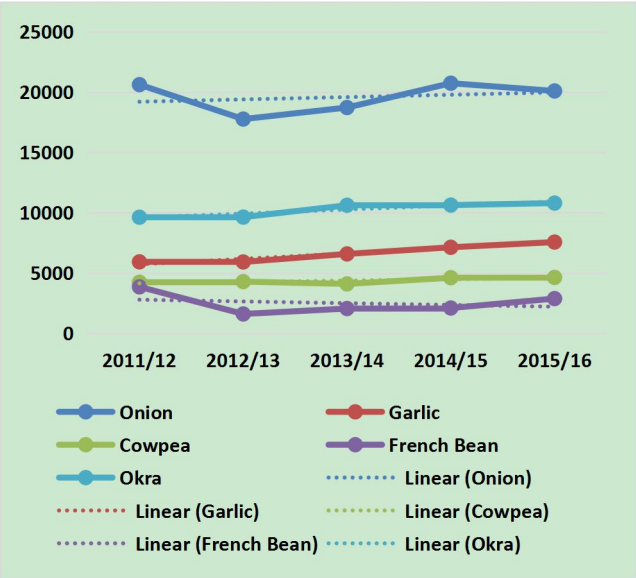

Figure 11; Trend in area cultivated for other major vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

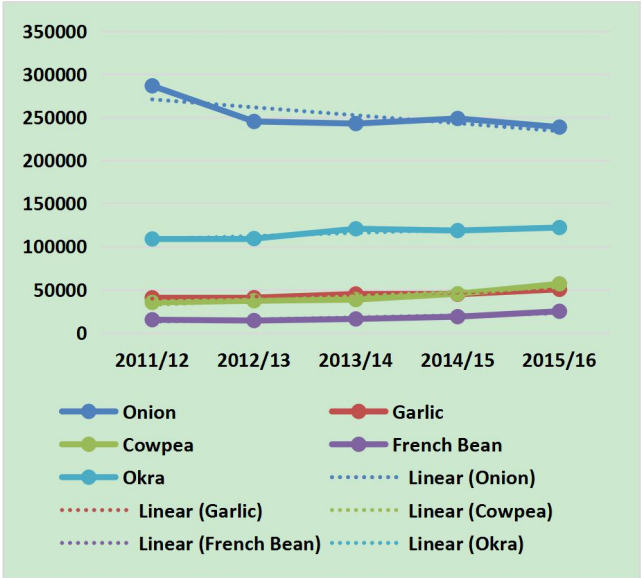

Figure 12; Trend in production of other major vegetables (2011/12–2015/16).

(Source: MoAD 2011/12 to 2015/16)

For onion, the overall trend is decreasing where area, production and yield has declined by 2.5%, 16.7% and 14.5% respectively. However, in the year of 2013/14 and 2014/15 area of onion is in increasing trend with percentage of 5.4 and 10.8 respectively and in the year of 2014/15 production of onion is increasing by 2.4 %. For garlic, area and production has increased by 27.7% and 24.1% respectively while the yield has declined by 2.8% over the 5 years. Similar is the case with okra where the area and production has increased by 12.2% each while yield has declined by 0.2%. For cowpea, the area, production and yield has increased by 9.4%, 61.2% and 47.4% respectively with 4.4 % decline in area in year 2013/14. The area under cultivation for French bean has declined by 25.3% while production and yield has increased by 64.4% and 120.1% respectively. However, there is a decline in yield in 2015/16 by 2.9% attributed by the greater increase in area than the production.

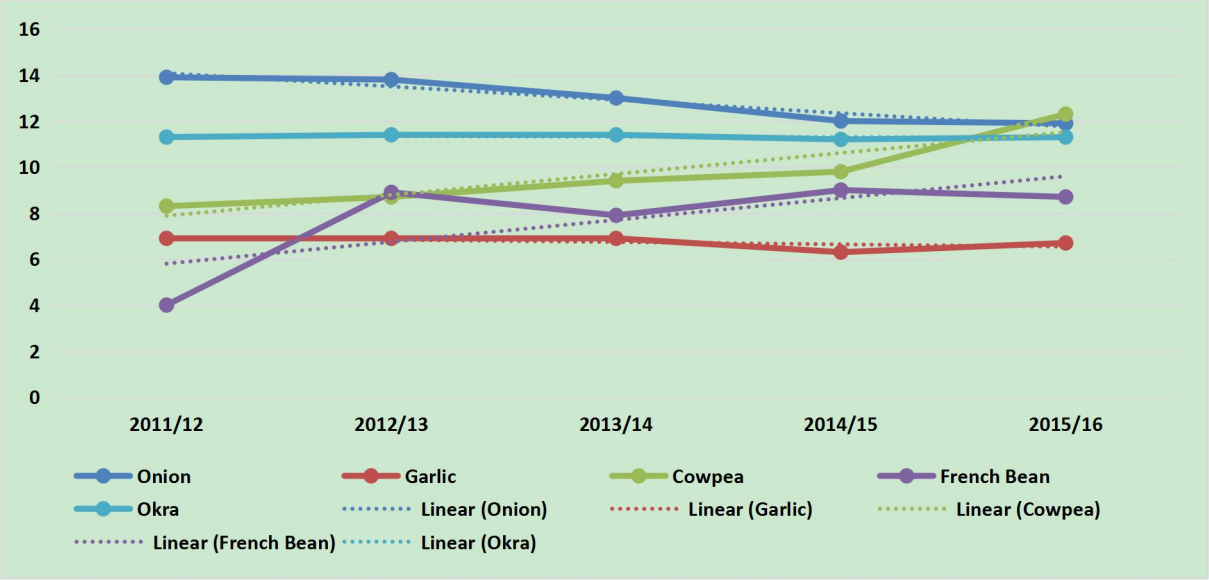

Figure 13; Trend in yield of other major vegetables (2011/12–2015/16)**.**

(Source: MoAD 2011/12 to 2015/16)

4. Conclusion

Over the past 40 years (from 1977/78 to 2016/17), the vegetables cultivation area has jumped by 222.8% while production has increased by 728.21% and productivity has increased by 156.6% during this course. The area under cultivation of vegetables is continuously increasing every year with a varying rate except for the years 1998/99 and 2015/16 where it has decreased than the previous year. Similar is the trend in production scenario of vegetables, which is continuously increasing each year with a varying rate except for the years 1980/81 and 1998/99 where it has decreased than the previous year.

During the period of 5 years (2011/12 - 2015/16), solanaceous vegetables has an increasing trend in area, production and yield except for the area under cultivation for eggplant which has declined by 5.2%. Similarly, cruciferous vegetables have an increasing trend in area, production and yield except for the area under cultivation for radish which has declined by 6.0%. Cucurbitaceous vegetables has an increasing trend in area and production while there is an declining trend in yield except for the yield of cucumber which was increased by 15.8%.

In case of other major vegetables, the overall trend for onion is decreasing where area, production and yield has declined by 2.5%, 16.7% and 14.5% respectively; area under cultivation and production of garlic has increased by 27.7% and 24.1% respectively. The area under cultivation for french bean has declined by 25.3% while production and yield has increased by 64.4% and 120.1% respectively.

With the limited area for expansion of cultivation area, increasing the production efficiency is the only way to meet the growing demand of vegetables. Production efficiency can be further enhanced by overcoming several production related barriers such as low scale- lack of commercialization; dependency over traditional crops and local varieties having low yield; inputs and technology associated constraints, etc. Overall vegetable sector development requires efforts to enhance post harvest operation to reduce the post-harvest losses and enhance value chain with a major concern on value addition of vegetables.

Appendix

Fiscal Year	Area (ha.)	% Change in Area	Production (Mt.)	% Change in Production	Yield (Mt./ha.)	% Change in Yield
1977/78	88000		466000		5.3	

1978/79	91000	3.4	491000	5.4	5.4	1.9
1979/80	96000	5.5	528000	7.5	5.5	1.9
1980/81	104000	8.3	521336	-1.3	5.0	-8.9
1981/82	118172	13.6	625099	19.9	5.3	5.5
1982/83	125693	6.4	667789	6.8	5.3	0.4
1983/84	130162	3.6	700334	4.9	5.4	1.3
1984/85	138200	6.2	743000	6.1	5.4	-0.1
1985/86	138586	0.3	782534	5.3	5.6	5.0
1986/87	138964	0.3	838948	7.2	6.0	6.9
1987/88	139500	0.4	874523	4.2	6.3	3.8
1988/89	140033	0.4	922118	5.4	6.6	5.0
1989/90	140524	0.4	967167	4.9	6.9	4.5
1990/91	140500	0.0	1074648	11.1	7.6	11.1
1991/92	140500	0.0	1127840	4.9	8.0	4.9
1992/93	140500	0.0	1179000	4.5	8.4	4.5
1993/94	140500	0.0	1197496	1.6	8.5	1.6
1994/95	140500	0.0	1211507	1.2	8.6	1.2
1995/96	144368	2.8	1327298	9.6	9.2	6.6
1996/97	146503	1.5	1357435	2.3	9.3	0.8
1997/98	149979	2.4	1449742	6.8	9.7	4.3
1998/99	140177	-6.5	1342567	-7.4	9.6	-0.9
1999/00	149030	6.3	1489665	11.0	10.0	4.4
2000/01	157162	5.5	1652979	11.0	10.5	5.2
2001/02	161048	2.5	1738086	5.1	10.8	2.6
2002/03	165988	3.1	1799973	3.6	10.8	0.5
2003/04	172586	4.0	1890100	5.0	11.0	1.0
2004/05	180823	4.8	2065193	9.3	11.4	4.3
2005/06	189864	5.0	2190122	6.0	11.5	1.0
2006/07	191922	1.1	2298689	5.0	12.0	3.8
2007/08	208108	8.4	2538904	10.5	12.2	1.9
2008/09	225154	8.2	2754406	8.5	12.2	0.3
2009/10	235098	4.4	3003821	9.1	12.8	4.4
2010/11	244102	3.8	3203563	6.6	13.1	2.7
2011/12	245036	0.4	3298816	3.0	13.5	2.6
2012/13	246392	0.6	3301684	0.1	13.4	-0.5
2013/14	256442	4.1	3440722	4.2	13.4	0.1
2014/15	266937	4.1	3580085	4.1	13.4	0.0
2015/16	250150	-6.3	3700969	3.4	14.8	10.3
2016/17	284135	13.6	3859492	4.3	13.6	-8.2

(Source: Vegetable Development Directorate, 2014/15 & MoAD 2017/18)

Appendix 1. Area, production and yield of Vegetables in Nepal from 1977/78 to 2016/17

Vegetables	Parameters	Year				
		2011/12	2012/13	2013/14	2014/15	2015/16
Family: Solanaceae						
Tomato	Area (ha)	17538	19728	17273	19725	20046
	Production (Mt)	282481	298594	232897	331736	386824.6
	Yield (Mt/ha)	16.1	15.1	13.5	16.8	19.3
Egg Plant	Area (ha)	9157	9276	8352	9231	8680.4
	Production (Mt)	121806	124669	119528	131405	128029.5
	Yield (Mt/ha)	13.3	13.4	14.3	14.2	14.7
Chilli	Area (ha)	7538	8908	7666	8239	9580.8
	Production (Mt)	55839	53688	61686	74902	95931.2
	Yield (Mt/ha)	7.4	6.0	8.0	9.1	10.0
Capsicum	Area (ha)	1062	1112	1318	1114	1183.8
	Production (Mt)	10499	10587	14216	11516	12369.3
	Yield (Mt/ha)	9.9	9.5	10.8	10.3	10.4
Family: Cruciferae						
Cauliflower	Area (ha)	32630	34065	33880	34704	34967
	Production (Mt)	491834	524205	352535	494765	550044.8
	Yield (Mt/ha)	15.1	15.4	10.4	14.3	15.7
Cabbage	Area (ha)	27916	27445	27026	27679	28071.4
	Production (Mt)	448980	468284	370660	453600	484036.8
	Yield (Mt/ha)	16.1	17.1	13.7	16.4	17.2
Radish	Area (ha)	17998	18415	18190	18188	16915.7
	Production (Mt)	262203	266112	272152	263215	268119.6
	Yield (Mt/ha)	14.6	14.5	15.0	14.5	15.9
Family: Cucurbitaceae						
Bottle Gourd	Area (ha)	6206	5933	6472	7207	8611.5
	Production (Mt)	102750	97155	102809	108208	129798.1
	Yield (Mt/ha)	16.6	16.4	15.9	15.0	15.1
Bitter Gourd	Area (ha)	6453	6426	7047	8113	10082.2
	Production (Mt)	88937	89053	100961	112309	132350.1
	Yield (Mt/ha)	13.8	13.9	14.3	13.8	13.1
Cucumber	Area (ha)	8500	8970	8789	9708	9396.8
	Production (Mt)	124262	127918	129266	150051	159041.8
	Yield (Mt/ha)	14.6	14.3	14.7	15.5	16.9
Pumpkin	Area (ha)	6336	6136	6733	7380	7203.4
	Production (Mt)	92773	91961	97569	106547	103169.6
	Yield (Mt/ha)	14.6	15.0	14.5	14.4	14.3
Family: Others (Amaryllidaceae, Leguminosae, Malvaceae)						
Onion	Area (ha)	20593	17740	18698	20712	20070
	Production (Mt)	286467	245102	242675	248584	238590.7
	Yield (Mt/ha)	13.9	13.8	13.0	12.0	11.9
Garlic	Area (ha)	5911	5904	6569	7119	7551
	Production (Mt)	40630	40757	45035	44723	50426
	Yield (Mt/ha)	6.9	6.9	6.9	6.3	6.7
Cowpea	Area (ha)	4224	4273	4086	4599	4620.7
	Production (Mt)	35223	37149	38523	45287	56790.1
	Yield (Mt/ha)	8.3	8.7	9.4	9.8	12.3
French Bean	Area (ha)	3841	1594	2044	2087	2869.8
	Production (Mt)	15177	14210	16087	18688	24953.3
	Yield (Mt/ha)	4.0	8.9	7.9	9.0	8.7
Okra	Area (ha)	9609	9619	10600	10613	10781.4
	Production (Mt)	108806	109268	120660	118585	122101.6
	Yield (Mt/ha)	11.3	11.4	11.4	11.2	11.3

(Source: MoAD 2011/12 to 2015/16)

Appendix 2. Area, production and yield of some major vegetables in Nepal from 2011/12 to 2015/16

Authors' Contributions

The article is the outcome of collective work of all the authors. Author DG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors GL and BP managed the analysis of the study. Authors SK and BB managed the literature searches. All authors read and approved the final manuscript.

Conflict of Interest

No conflict of interest was reported by the authors.

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