

# **Chapter 6**

## **Agricultural Production and Productivity Trends**

### **Introduction**

Production is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). It is an act of creating output, a good or a service which has value and contributes to the utility of individuals.

The productivity has been used with different meanings and has aroused many conflicting interpretations. Sometimes it is considered as the overall efficiency with which a production system works, while others have defined it as a ration of output to resource expanded separately or collectively. This term has been used incorrectly and interchangeably with production. In reality, production refers to the volume of output, while productivity signifies the output in relation to resources expanded. The quantum of production can be increased by employing more resources without increasing productivity and productivity per unit terms can be increased without increasing production by employing less input for the same production level. It is commonly agreed that productivity is the ability of a production system to produce more, economically and efficiently. Therefore, agricultural productivity can be defined as a measure of efficiency in an agricultural production system which employs land, labour, capital and other related resources ([shodhganga.inflibnet.ac.in](http://shodhganga.inflibnet.ac.in)). Productivity is an average determinant of the effectiveness of production. It can be articulated as the ratio of output to inputs used in the production method, i.e. output per unit of input. When all outputs and inputs are incorporated this is measured in productivity.

In recent years many attempts have been made to define the connotation of agricultural productivity. Dewett (1966;66) explains it as, “productivity expresses the varying relationship between agricultural output and one of the major inputs, like, land or labour or capital, other complementary factors remaining the same...” It may be kept in mind that productivity is physical rather than a value concept. The connotation of agricultural productivity engaged the attention of many an economist at the 23<sup>rd</sup> Annual Conference of the Indian Society of Agricultural Economics. Some economist suggested that the yield per acre should be considered to express agricultural productivity. A number of objections were raised against this because it considers only land which is just one factor of production while other factors are also responsible, and therefore, it will be arbitrary to attribute productivity entirely to land and express it per hectare of land. It was suggested, for instance, that productivity should also be measured in terms of per unit of labour and different regions be compared on that basis.

After a thorough discussion, it was generally agreed that the yield per hectare may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible cause for the variations while comparing it with the other regions ([shodhganga.inflibnet.ac.in](http://shodhganga.inflibnet.ac.in)).

Sikkim is called as Drenjong which means “valley of rice” according to Tibetan language, while the Bhutias call it Beyul Demazong , which means “the hidden valley of rice”. The Lepcha people called it Nye-mae-el, meaning “paradise”. The name itself signifies the meaning of agriculture to the people of Sikkim. Agriculture is the chief occupation of the majority of the people. It provides not only employment but also food for most of them. There is substantial variation in agriculture practices in the state because some areas are not appropriate for agriculture, some areas are arid and infertile and some thinly populated while some are fertile. Density of population in different districts also has an influence on the agriculture practice of a particular district.

Sikkim is a hilly State in the Eastern Himalayas where agricultural practices and adaptations are highly variable in time and space due to varying altitudes and agro-climatic situations. The net cultivable area in Sikkim is estimated to be around 79,000 hectare (11.13%); with irrigated area of 15 percent of the total operational holdings of 1,10,000 hectares. About 80 percent of the people are directly or indirectly dependent on scarce land resources for their livelihood. The state being hilly has little scope of industrial growth, and hence has not adequately succeeded in decreasing the pressure on agriculture/horticulture as the agrarian population has decreased at minimal since its merger in the Indian Union in 1975 ([www.visva-bharati.ac.in](http://www.visva-bharati.ac.in)). Policies have been opted for agriculture and horticulture development in Sikkim in order to improve yield and also to maintain the major production systems through appropriate management of resources. The endeavor is to establish ecologically sustainable, economically beneficial and resources proficient cropping systems along with the generation of employment to attain a positive looking transformation.

The Central Government has sponsored many Schemes in order to improve different crop production like Oilseeds Production Programme, National Pulses Development Programme, Coarse Cereals, Rice Minikit Programme, Accelerated Maize Development Programme, and National Watershed Development Programme for rainfed area and has also been steering the spread and timely delivery of scientific and better farm technologies to the grass-root levels in the state. Newly initiated centrally sponsored schemes through Macro-Management mode are initiated to add more in intensification of infra-structure (Strategic Research and Extension Plan of South District-2006).

Agriculture in Sikkim is the major economic activity that is practiced on terraced fields which have been laboriously created from steep hillsides. Sikkim is the largest producer of

cardamom and also boasts to utilize largest area for its cultivation. Tea is exported to USSR & Germany. Sikkim's economy broadly depends on agriculture which provides livelihood to the majority of population in the state ([sikkim.nic.in](http://sikkim.nic.in)).

### **Sikkim's Geography and Agriculture**

Physical features of the state of Sikkim have made agricultural environment extremely varied. Sikkim's altitude and slope play a vital role to determine the agriculture milieu. The agro-climatic zones of the state have significant variations from sub-tropical to warm-temperate and the cool-temperate to alpine zones; hence there are different agro-ecosystems that exist to create agricultural biodiversity.

Basically, largest part of the land available for cultivation is located within elevation ranges from 300-1800 m. In areas like Lachen, Lachung, Dzongu, Phadamchen, Ribdi, Bharyang, and Uttaray, subsistence agriculture is being practiced up to 3000m. Some crops like oil seeds, leafy vegetables, potatoes, and medicinal plants are cultivated in high elevations (3000-4000m) up to Thangu and Muguthang in North District. Under certain traditional practice, farmers grow huge number of local and conventional varieties and land races of crops to maintain food security.

### **Agrarian Community in Sikkim**

The economy of Sikkim is associated with agriculture that renders the source of livelihood and economic security of large native population. The development however, has been constrained because of biotic and abiotic factors. It has been estimated that more than 80 percent of the rural population depends on agriculture and other allied sectors in order to secure their economic, food and nutritional aspects. The agriculture systems accomplished in Sikkim are incorporated in environments that have produced through years of experimentation by the farmers. A marginal improvement has been seen in the lifestyle of the farmers due to the implementation of modern technologies.

Agriculture is dominated by the Nepalis who are industrious and practice intensive agriculture (Bhasin and Bhasin, 1996). The Bhutias, in north Sikkim, with their large animal herds practice pastoral economy on high altitudes, while Lepchas practice subsistence agriculture (Khawas, 2012).

The original natives of Sikkim were not agriculturists; actually, they led a very primitive lifestyle. The natives were engaged in collecting wild roots, fruits, hunting, and fishing in order to sustain their family. When Bhutia people migrated to Sikkim, they started semi-pastoral economy and sedentary form of farming. They located flat pieces of land in areas adjoining meadows and started to plough those lands. The settled agriculture got initiated in Sikkim only with the arrival of Nepali community. These people were active, hard working

and innovative, and at the very first instant after their arrival they started clearing large tracts of forest land for making them suitable for agriculture purpose.

Sikkim is a tiny hilly state lying in the lap of Eastern Himalayas where agricultural adaptations and practices are extremely inconsistent in tempo-spatial factors due to varying elevation and agro-climatic conditions. The total geographical area about 15.22 percent (total operated land except forest area as per 2016 landuse data) is devoted to agriculture but the available area of agricultural purpose is declining due to conversion of cultivable land into non-agricultural purposes such as development of industries, expansion of town, roads construction, hydel-power projects, construction of different buildings etc. Farming has become handicapped due to small and fragmented holdings, inadequate irrigation facilities and lack of proper farm mechanization and regular occurrences of natural hazards like landslides, earthquakes etc. The above indicators suggest that emphasis should be given to intensive and cautious use of limited land so that the per capita land yield and production is supported to some extent. As per 2015-16 agriculture +horticulture land use covers of South district is estimated to be around 41790 hectare about 5.89 percent of the total geographical area.

### **Major Agricultural Crops**

The principal food crops cultivated in the area include maize, rice, wheat, finger-millet, barley, buckwheat, pulses, oilseeds and cash crops such as cardamom, ginger, orange and tea. The annual growth of Gross State Domestic Product of Sikkim at current prices in 2014-15 accounted by agriculture is 13.35 percent. Sikkim's Gross Domestic Product was estimated at US dollar 1.57 billion in 2014 and it constitutes the third smallest GDP among other states in India. But the crop productivity (production per unit area) in Sikkim was far below the national and regional average for major field crops.

### **Crop Production**

The tables given below present the crop production in Sikkim during the periods 1975-76 to 1995-96 and 2005-06 to 2015-16.

**Table 6.1: Crop Production of Sikkim (1975-76 to 1995-96) in 000' Tons**

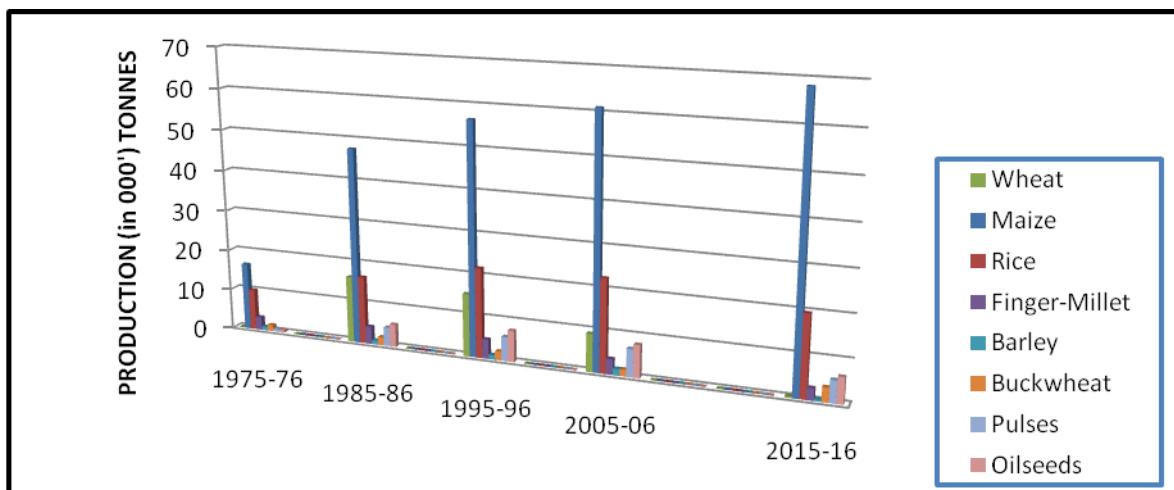
Crops	1975-76 Mean ±S.D.	Standard Error	1985-86 Mean ±S.D.	Standard Error	1995-96 Mean ±S.D.	Standard Error
Maize	16.50±9.8590	4.0249	47.60±18.7510	7.6550	56.56±15.4660	6.3140
Rice	10.00±5.6213	2.2949	16.50±9.8590	4.0249	21.87±14.3805	5.8708
Wheat	0.15±.0892	.0364	16.20±9.6332	3.9327	15.30±8.6487	3.5308
Finger-Millet	3.20±2.6734	1.0914	4.30±2.6076	1.0645	4.75±3.0331	1.2382
Barley	0.90±.6723	.2744	1.00±.6841	.2792	1.08±.8369	.3416
Buck-wheat	1.50±1.0881	.4442	2.00±1.1471	.4683	2.19±1.5025	.6134
Pulses	0.70±.4604	.1879	4.60±3.0331	1.2382	5.92±3.5777	1.4605
Oilseed	0.70±.4604	.1879	5.55±3.8987	1.5916	7.63±5.8020	2.3686

*Source:* DESME, 2002, 2006-07, Economic Survey-2006-07, Progress Report-2015-16.

**Table 6.2: Crop Production of Sikkim (2005-06 to 2015-16) in 000' Tons**

Crops	2005-06 Mean ±S.D.	Standard Error	2015-16 Mean ±S.D.	Standard Error
Maize	61.10±20.4254	8.3386	68.31±25.3929	10.3666
Rice	22.69±9.0774	3.7058	19.69±11.2427	4.5898
Wheat	9.20±6.3245	2.5819	0.35±19.35	.0797
Finger-Millet	3.78±2.5343	1.0346	2.91±2.0503	.8370
Barley	1.59±1.0507	.4289	0.47±.2429	.0991
Buckwheat	1.64±1.1242	.4589	3.47±2.1128	.8625
Pulses	6.76±4.2426	1.7320	5.38±3.7416	1.5275
Oilseeds	7.95±3.4641	1.4142	6.31±3.8987	1.5916

Source: DESME, 2002, 2006-07, Economic Survey-2006-07, Progress Report-2015-16



**Figure 6.1: Crop Production of Sikkim (1975-76 to 2015-16) in 000' Tons**

The above tables (6.1 & 6.2) illustrate crop production of Sikkim (1975-76 to 2015-16) in 000' tons which shows the significant mean  $\pm$ S.D. and standard error of eight different crops such as maize, rice, wheat, finger-millet, barley, buckwheat, pulses and oilseeds. The highest production of crop has been seen in maize and it is rising in every decade from 1975-76 to 2015-16, the mean  $\pm$ S.D. in 1975-76 (16.50±9.8590), 1985-86 (47.60±18.7510), 1995-96 (56.56±15.4660), 2005-06 (61.10±20.4254) and 2015-16 (68.31±25.3929) and their corresponding errors are calculated as 1975-76 (4.0249), 1985-86 (7.6550), 1995-96 (.3140), 2005-06 (8.3386) and 2015-16 (10.3666). The second highest crop production is of rice which has been fluctuating in every decade and the significant mean  $\pm$ S.D in 1975-76 (10.00±5.6213), 1985-86 (16.50±9.8590), 1995-96 (21.87±14.3805) 2005-06 (22.69±9.0774) and 2015-16 (19.69±11.2427) and its corresponding errors are calculated 1975-76 (2.2949), 1985-86 (4.0249), 1995-96 (5.8708), 2005-06 (3.7058) and 2015-16 (4.5898). After maize and rice, other crops come such as wheat, finger-millet, barley, buckwheat, pulses and oilseeds

and their production is not progressively increasing. Wheat come under third position from 1985-86 to 2005-06, but less production of wheat has been seen in 2015-16.

Maize is the principal crop grown in Sikkim. The crop is easily grown in dry and sloping lands that are not suitable for the cultivation of rice (Choudhury, 2006). The production of maize tremendously increased from 1975-76 to 2015-16. Amongst the other crops maize production is maximum in the state of Sikkim. Similarly, rice is the main food item and ranks second after maize. The per capita availability of rice in the state is 158 gms/day, which is far below the National average of 417 gm during 2001-02. Wheat production was slowly increasing during 1995-96, but the trend in 2005-06 and 2015-16 shows decrease in production. The production of other crops has also been fluctuating during every decade according to annual report.

### Crop productivity

Crop productivity is a multi-dimensional concept, which includes technological advancement, effective management of available resources, and organizational setup for crop production. These factors in turn affect the relative crop production in the region. It may be pointed out, that the development of agriculture should be assessed by evaluating the use of various inputs i.e., the extent of cultivated area, provision of irrigation, fertilizers, improved varieties of seeds and labour availability. It provides food for growing population and helps to extend the secondary and tertiary sectors and thereby increase the income for the welfare of the population living in rural areas ([shodhganga.inflinet.ac.in](http://shodhganga.inflinet.ac.in)).

**Table 6.3: Crop Productivity of Sikkim (1975-76 to 1995-96) Kg/Ha**

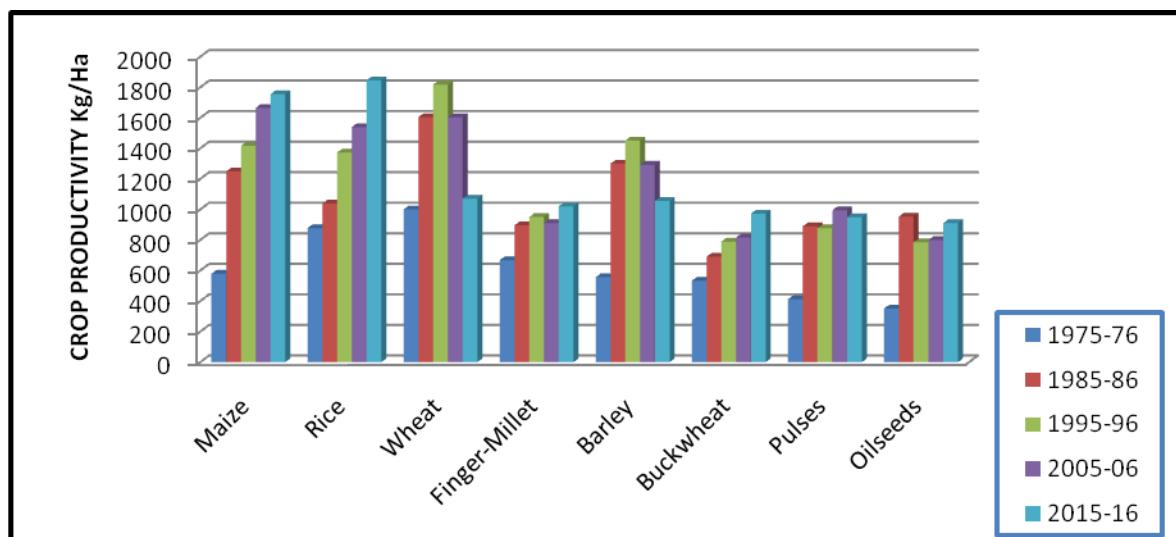
Crops	1975-76 Mean ±S.D.	Standard Error	1985-86 Mean ±S.D.	Standard Error	1995-96 Mean ±S.D.	Standard Error
Maize	579±24.8596	10.1488	1249±23.1257	9.4410	1416±17.6522	7.2064
Rice	877±22.5831	9.2195	1038±15.4402	6.3034	1372±27.3056	11.1475
Wheat	1000±29.2232	11.9303	1604±26.0000	10.6144	1817±19.1520	7.8187
Finger-Millet	667±32.2924	13.1833	896±24.2239	9.8893	950±19.2873	7.8740
Barley	556±22.7332	9.2808	1300±21.8174	8.9069	1451±23.2292	9.4833
Buckwheat	533±16.8166	6.8653	690±31.4579	12.8426	790±27.6767	11.2989
Pulses	412±7.7974	3.1832	889±20.8134	8.4970	878±19.1891	8.0911
Oilseeds	350±19.2769	7.8697	953±23.6896	9.6712	785±24.5601	10.0266

Source: DESME, 2002, 2006-07, Economic Survey-2006-07, Sikkim Gazatteer-2013, Progress Report-2015-16.

**Table 6.4: Crop Productivity of Sikkim (2005-06 to 2015-16) Kg/Ha**

Crops	2005-06 Mean $\pm$ S.D.	Standard Error	2015-16 Mean $\pm$ S.D.	Standard Error
Maize	1665 $\pm$ 25.8843	10.5672	1754 $\pm$ 28.7262	11.7274
Rice	1539 $\pm$ 20.9666	8.5596	1845. $\pm$ 19.4422	7.9372
Wheat	1603 $\pm$ 20.3273	8.2985	1071 $\pm$ 29.8529	12.1874
Finger-Millet	911 $\pm$ 17.9220	7.3166	1020 $\pm$ 25.7837	10.5261
Barley	1293 $\pm$ 24.8435	10.1423	1055 $\pm$ 23.9448	9.7672
Buckwheat	816 $\pm$ 16.6973	6.8166	972 $\pm$ 23.1430	9.4481
Pulses	994 $\pm$ 19.6875	8.0374	949 $\pm$ 28.8929	11.7954
Oilseeds	799 $\pm$ 18.9631	7.7416	910 $\pm$ 26.8700	10.9696

Source: DESME, 2002, 2006-07, Economic Survey-2006-07, Sikkim Gazatteer-2013, Progress Report-2015-16.



**Figure 6.2: Crop Productivity of Sikkim (1975-76 to 2015-16) Kg/Ha**

The table and figure given above show the crop productivity of eight different crops such as maize, rice, wheat, finger-millet, barley, buckwheat, pulses and oilseeds of Sikkim in various years. In the latest data i.e. 2015-16, the highest productivity is in rice and maize, the mean  $\pm$ S.D. are (1845. $\pm$ 19.4422) and (1845. $\pm$ 19.4422) and its corresponding errors are calculated as (7.9372) and (11.7274).

The crop productivity (production per unit area) in Sikkim is far below the national and regional average for major field crops (*Sikkim Gazetteer*, 2013). In order to assess crop productivity in each district of Sikkim at an interval of five years in 2010-11 to 2014-15,

Yang's (1965) 'Crop Yield Index' method is applied for the calculation of crop productivity. Some of the major crops grown in the districts are considered for the productivity analysis.

**Table 6.5: Crop Yield Index for East District of Sikkim**

Crops (Cereals)	Yield in Kg/Ha		Area under crop in district (in '000 ha)	Crop yield in district as a percentage of the entire state Col.3/Col.2×100	Percentage multiplied by area under crops (Col.4×Col.5)
	Average yield in State	Average yield in each district			
1	2	3	4	5	6
Maize	1687.67	1479.05	9.03	87.64	791.39
Rice	1772.78	1778.47	4.91	100.32	492.57
Wheat	1044.76	1156.67	0.58	110.71	64.21
Finger-Millet	984.36	1012.86	0.84	102.90	86.44
Barley	991.35	985.56	0.28	99.42	27.84
Buckwheat	943.32	963.90	1.44	102.18	147.14
<b>Total</b>			<b>17.08</b>		<b>1609.59</b>

*Crop Yield Index for East district=1609.59/17.08=94.23 percent*

**Table 6.6: Crop Yield Index for West District of Sikkim**

Crops (Cereals)	Yield in Kg/Ha		Area under crop in district (in '000 ha)	Crop yield in district as a percentage of the entire state Col.3/Col.2×100	Percentage multiplied by area under crops (Col.4×Col.5)
	Average yield in State	Average yield in each district			
1	2	3	4	5	6
Maize	1687.67	1702.00	13.86	100.84	1397.64
Rice	1772.78	1858.98	3.55	104.86	372.25
Wheat	1044.76	896.32	0.43	0.86	0.37
Finger-Millet	984.36	1008.77	0.79	1.02	0.81
Barley	991.35	935.50	0.03	0.94	0.03
Buckwheat	943.32	894.05	0.98	0.95	0.93
<b>Total</b>			<b>19.64</b>		<b>1772.03</b>

*Crop Yield Index for North district=1772.03/19.64=90.23 percent*

**Table 6.7: Crop Yield Index for North District of Sikkim**

Crops (Cereals)	Yield in Kg/Ha		Area under crop in district (in '000 ha)	Crop yield in district as a percentage of the entire state Col.3/Col.2×100	Percentage multiplied by area under crops (Col.4×Col.5)
	Average yield in State	Average yield in each district			
1	2	3	4	5	6
Maize	1687.67	1479.05	2.825	87.63	247.55
Rice	1772.78	1287.17	0.995	72.60	72.23
Wheat	1044.76	980.00	0.260	93.80	24.39
Finger-Millet	984.36	1884.34	0.605	191.42	115.81
Barley	991.35	1125.07	0.140	113.45	15.88
Buckwheat	943.32	891.32	0.195	94.49	18.43
<b>Total</b>			<b>5.020</b>		<b>494.29</b>

*Crop Yield Index for North district=494.29/5.020=98.46 percent*

**Table 6.8: Crop Yield Index for South District of Sikkim**

Crops (Cereals)	Yield in Kg/Ha		Area under crop in district (in '000 ha)	Crop yield in district as a percentage of the entire state Col.3/Col.2×100	Percentage multiplied by area under crops (Col.4×Col.5)
	Average yield in State	Average yield in each district			
1	2	3	4	5	6
Maize	1687.67	1694.62	14.32	100.41	1437.87
Rice	1772.78	1842.76	2.14	103.94	222.43
Wheat	1044.76	1088.34	0.26	104.17	27.08
Finger-Millet	984.36	961.34	0.75	97.66	73.25
Barley	991.35	872.90	0.12	88.05	10.57
Buckwheat	943.32	965.49	1.43	102.35	146.36
<b>Total</b>			<b>19.02</b>		<b>1917.56</b>

*Crop Yield Index for North district=1917.56/19.02=100.82 percent*

The procedure for calculating ‘Crop Yield Index’ of four districts of Sikkim has been taken from Yang’s Crop Yield Index.

The computed values of productivity indices for each district of the state are explained below.

#### I. Productivity Districts Based on Cereal Crops Yield Index:

According to Crops Yield Index there are four productivity districts (regions) for cereal crops (maize, rice, wheat, finger-millet, barley and buckwheat) in Sikkim. These are:

*i. Very High Productivity District*

The South district is characterized by very high productivity in cereal crops with an index value of 100.82 percent.

*ii. High Productivity District*

The North district possesses high productivity in cereal crops with an index value of 98.46 percent.

*iii. Medium Productivity District*

The East district has medium productivity of cereal crops with the index values of 94.23 percent.

*iv. Low Productivity District-*

The West district possesses shows low productivity in cereal crops with an index value of 90.23.

## **II. Productivity Districts Based on Pulse Crops Yield Index**

The cultivation of pulses is very significant in the state of Sikkim. The pulses productivity varies according to the tempo-spatial variation of the state. The areas of high, medium and low productivity can be seen within four districts of Sikkim.

*i. High Productivity District*

High productivity region covers two districts i.e. South and East districts of Sikkim with the index values of 100.67 and 102.47 percent respectively.

*ii. Medium Productivity District*

Medium productivity is confined to the West district of Sikkim with the index value of 93.90 percent.

*iii. Low Productivity District*

The low productivity region covers only one district i.e. North district having index value of 70.83 percent and lying in the northern part of state.

## **III. Productivity District Based on Oilseed Crops Yield Index**

The areas of high, medium and low productivity of oilseeds within four districts of Sikkim are given below:

*i. High Productivity District*

High productivity region covers two districts i.e. South and East of Sikkim with the index values of 103.11and 103.01 percent respectively.

*Medium Productivity District*

West district of Sikkim having index value of oilseed is 97.02 percent has medium productivity.

*iv. Low Productivity District*

The low productivity region covers only one district i.e. North district having index value of 86.41 percent.

### **Production and Productivity of the Study Area (South District)**

Where land resources are scarce, the principal means of raising production to keep pace with the growth of population is by raising yield per hectare. However, raising the productivity of land does not mean only raising the yield of individual crops. It encompasses the whole output of a farm or country in relation to the total area of farm land, and which may also be raised by changing the pattern of crop production and towards more intensive system of cultivation or towards higher value crops ([shodhganga.inflibnet.ac.in](http://shodhganga.inflibnet.ac.in)).

**Table 6.9: Area (in 000'ha) of Major Crops in South District (2000-01 to 2005-06)**

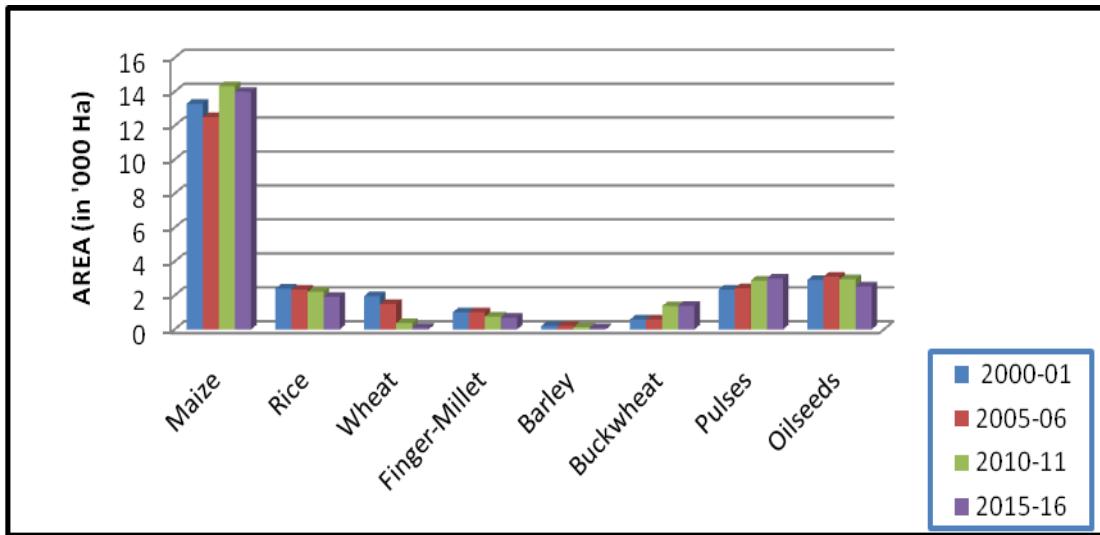
Sl. No.	Crops	2000-01 Mean ± S.D.	Standard Error	2005-06 Mean ± S.D.	Standard Error
1.	Maize	13.30±9.9799	4.0743	12.50±.1982	.0809
2.	Rice	2.40±1.3130	.5360	2.34±1.5165	.6191
3.	Wheat	1.96±1.2176	.4971	1.50±1.0749	.4388
4.	Finger-Millet	1.00±.6841	.2792	1.01±1.0881	.4442
5.	Barley	0.20±.1056	.0431	0.20±.1056	.0431
6.	Buckwheat	0.58±.3045	.1243	0.58±.3045	.1243
7.	Pulses	2.35±1.4601	.5961	2.42±1.5401	.6287
8.	Oilseeds	2.91±.2475	.1010	3.10±2.1511	.8781

Source: DESME, 2004-05, 2006-07, Progress Report 2005-06 & 2015-16.

**Table 6.10: Area (in 000'ha) of Major Crops in South District (2010-11 to 2015-16)**

Sl. No.	Crops	2010-11 Mean ± S.D.	Standard Error	2015-16 Mean ± S.D.	Standard Error
1.	Maize	14.33 ±6.0663	2.4765	14.00 ±5.7619	2.3523
2.	Rice	2.22 ±1.3206	.5391	1.92 ±1.3244	.5407
3.	Wheat	0.37 ±.1381	.0563	0.11 ±.0583	.0238
4.	Finger-Millet	0.75 ±.2625	.1071	0.70 ±.4604	.1879
5.	Barley	0.14 ±.0509	.0208	0.07 ±.4604	.1879
6.	Buckwheat	1.38 ±.6706	.2737	1.40 ±1.0469	.4274
7.	Pulses	2.88 ±1.3446	.5489	3.01 ±2.1156	.8637
8.	Oilseeds	2.95 ±1.6260	.6638	2.54 ±1.6994	.6937

Source: DESME, 2004-05, 2006-07, Progress Report 2005-06 & 2015-16.



**Figure 6.3:** Area (in 000'ha) of major crops in South District (2000-01 to 2015-16)

Area under different crops of South district can be seen in tables (6.9 & 6.10) at an interval of five years i.e. 2000-01 (53.85 %), 2005-06 (52.85%), 2010-11(57.28%) and 2015-16 (58.95%). All through the years, area under maize has been highest and much above other crops. The areas under pulses, oilseeds and rice are almost same. Wheat, buckwheat and finger millet have much less area while barley has least area. As per 2015-16 agricultural land use covers of South district is estimated to be around 23750 hectare about 3.34 percent of the total geographical area.

**Table 6.11: Major Crop Production (000' Tons) in South District (2000-01 to 2005-06)**

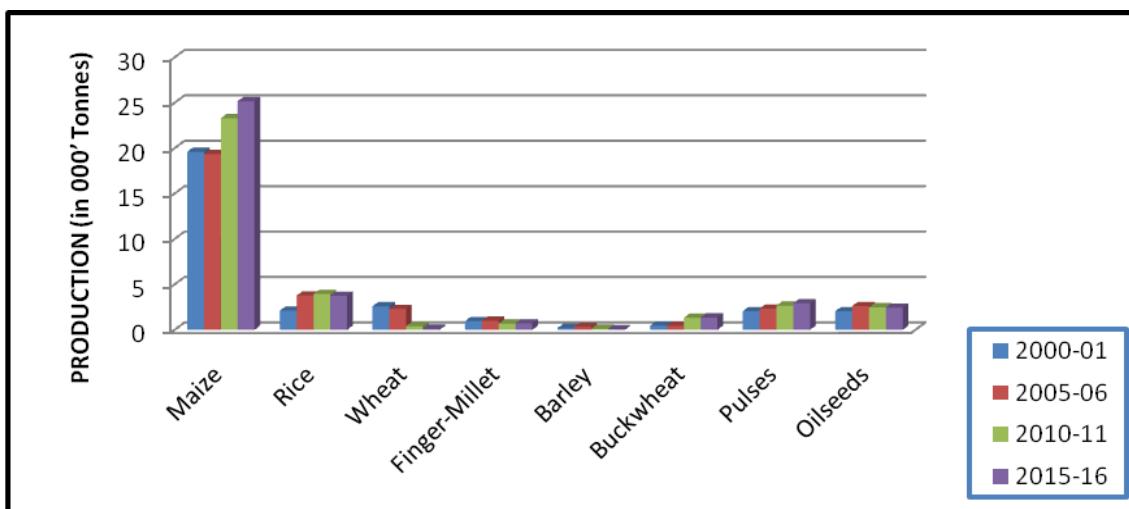
Sl. No.	Crops	2000-01 Mean ± S.D.	Standard Error	2005-06 Mean ± S.D.	Standard Error
1.	Maize	19.60±13.4313	5.4833	19.36±13.4014	5.4711
2.	Rice	2.11±.1574	.0642	3.77±2.1061	.8598
3.	Wheat	2.59±1.5849	.6470	2.30±1.4014	.5721
4.	Finger-Millet	0.95±.7010	.2862	1.01±1.0881	.4442
5.	Barley	0.20±.1056	.0431	0.32±.3200	.2112
6.	Buckwheat	0.46±.3033	.1238	0.44±.2150	.0877
7.	Pulses	2.05±1.3205	.5391	2.33±1.6456	.6718
8.	Oilseeds	2.05±1.3250	.5391	2.62±1.9266	.7865

Source: DESME, 2004-05, 2006-07, Progress Report 2010-11 and 2015-16.

**Table 6.12: Major Crop Production (000' Tons) in South District (2010-11 to 2015-16)**

Sl. No.	Crops	2010-11 Mean ± S.D.	Standard Error	2015-16 Mean ± S.D.	Standard Error
1.	Maize	23.31±15.1261	6.1752	25.18±14.7918	6.0387
2.	Rice	3.95±2.1621	.8827	3.74±2.2369	.9132
3.	Wheat	0.41±.1740	.0710	0.12±.0641	.0252
4.	Finger-Millet	0.69±.3974	.1622	0.71±.4604	.1879
5.	Barley	0.12±.0641	.0252	0.06±.0405	.0165
6.	Buckwheat	1.33±.9528	.3890	1.36±1.7933	.4258
7.	Pulses	2.67±2.0049	.8185	2.92±1.7933	.7321
8.	Oilseeds	2.49±1.8740	.7650	2.44±1.3446	.5489

Source: DESME, 2004-05, 2006-07, Progress Report 2010-11 and 2015-16.



**Figure 6.4:** Production (in 000' Tons) of major crops in South Sikkim (2000-01 to 2015-16)

Though maize is never a part of the staple food item it is taken as substitute food in absence of rice in Sikkim. Its production still contributes over 70 percent of the total food grains production in Sikkim. The production of maize in South District has always been at the top among all crops. A noteworthy increase in the production of maize has been seen in above table as per 2000-01 to 2015-16 data. Rice is the main staple food crop in Sikkim and it occupies second position in crops production. The production of rice, pulses and oilseeds is not satisfactory. The production of wheat and buckwheat is also less, but higher compared to finger-millet and barley.

**Table 6.13: Productivity (Kg/Ha) of Major Crops in South District (2000-01 to 2005-06)**

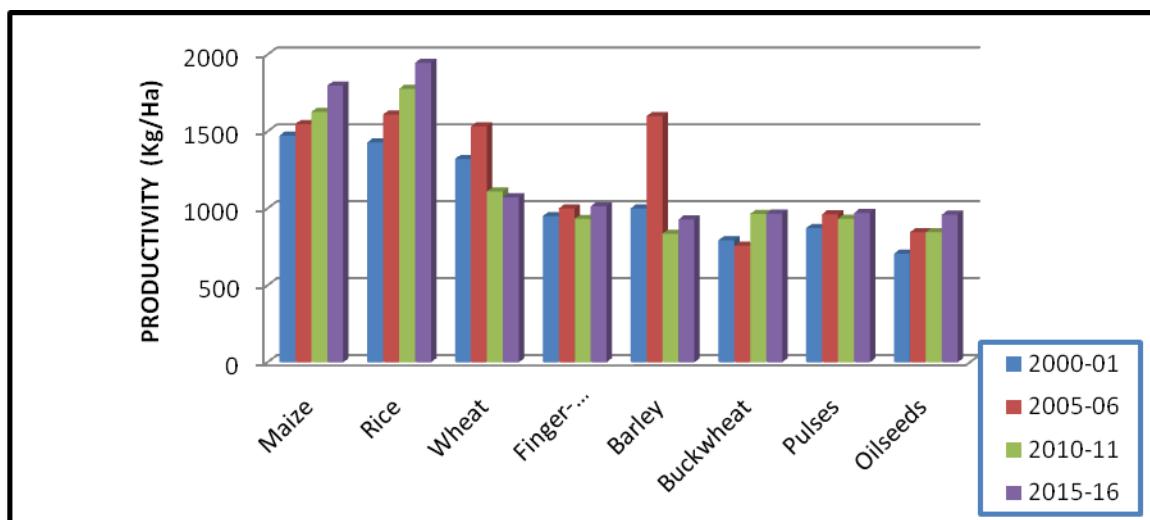
Sl. No.	Crops	2000-01 Mean ± S.D.	Standard Error	2005-06 Mean ± S.D.	Standard Error
1.	Maize	1473.68 ±.3312	.1356	1548.80 ±32.5453	13.2865
2.	Rice	1429.16 ±.2737	.1117	1611.11 ±20.2385	8.2623
3.	Wheat	1321.42 ±.3320	.1355	1533.33 ±28.4464	11.6132
4.	Finger-Millet	950.00 ±31.8622	13.0076	1000.00 ±29.3802	11.9944
5.	Barley	1000.00 ±29.3802	11.9944	1600.00 ±23.0391	9.4056
6.	Buckwheat	793.10 ±23.4520	9.5742	758.62 ±25.4872	10.4051
7.	Pulses	872.34 ±31.7285	12.9531	962.81 ±28.7888	11.7530
8.	Oilseeds	705.84 ±37.7518	15.4121	845.16 ±24.3557	9.9431

Source: DESME, 2004-05, 2006-07, Progress Report 2010-11 and 2015-16.

**Table 6.14: Productivity (Kg/Ha) of Major Crops in South District (2010-11 to 2015-16)**

Sl. No.	Crops	2010-11 Mean ± S.D.	Standard Error	2015-16 Mean ± S.D.	Standard Error
1.	Maize	1627.00±22.5299	9.1978	1798.57±32.7597	13.3741
2.	Rice	1778.20±19.9298	8.1363	1946.88±29.0998	11.8799
3.	Wheat	1110.00±22.6892	9.2628	1072.73±21.9271	8.9517
4.	Finger-Millet	932.00±29.6175	12.0913	1014.29±24.3228	9.9297
5.	Barley	835.80±22.7332	9.2808	928.57±26.0537	10.6364
6.	Buckwheat	965.00±26.5103	10.8228	966.66±27.0628	11.0483
7.	Pulses	932.77±17.8213	7.2755	971.10±32.3975	13.2262
8.	Oilseeds	845.93±29.1667	11.8827	959.50±23.7149	9.6816

Source: DESME, 2004-05, 2006-07, Progress Report 2005-06 & 2015-16.



**Figure 6.5:** Productivity (in Kg/Ha) of Major crops in South Sikkim (2000-01 to 2015-16)

The productivity of maize has been increasing. Within a period of five years it has increased by 4.9 percent from 2000-01 to 2005-06, likewise from the years of 2005-06 to 2010-11 increased by 4.8 percent, and again by 9.5 percent from 2010-11 to 2015-16. The productivity of rice was low in the year of 2000-01, but the productivity has suddenly increased from 2005-06 to 2015-16 and it is increased by 11.3 percent from 2000-01 to 2005-06, likewise from 2005-06 to 2010-11 it was increased by 9.4 percent, and 8.7 percent from 2010-11 to 2015-16. In the case of wheat the productivity has increased from 2000-01 to 2005-06, but after that productivity came down. The remaining crops like finger-millet, barley and buckwheat experience fluctuations in yield in every five years. But oilseeds production is seen to be increasing steadily. There are two groups of oilseeds in Sikkim i.e. rape & mustard, and soybean. The use of pulses with cereals is a very general practice in India. The practice is measured to be very scientific because of the high protein stuffing in the pulses, which are required for balanced food for a large population in the country dependent upon vegetarian food. Pulses like *kalo dal* and *paheli dal* are commonly grown in Sikkim.

### **Crop Combination - Weaver's Method**

A simple and suitable method of finding out the crop combinations with significant share in the total cropped area has been suggested by Weaver. He compared the actual percentage area under each crop on the basis of hypothetical percentage. Actually, this theoretical percentage share of a crop is diverse in different hypothetical situations. For instance, in a hypothetical monoculture area, the theoretical percentage share of a crop is 100 percent. For a two crop combination area it is 50 percent for each crop. For a three-crop combination it is 33½ percent for each and so on.

Thus to work out crop combination, first the areas under different crops as percentage to the total cropped area are calculated. Its highest percentage is then compared with the assumed value of one crop region i.e. 100. In the next step first two highest percentages are taken and compared to get the assumed values of a two-crop combination region i.e. 50 and 50. Similarly three highest percentages with 33½, 33½ and 33½ and four highest percentages with 25, 25, and 25 so on are compared. In each step it will get some value of  $\sigma_2$ . The theoretical percentage which gives the minimum value of  $\sigma_2$  is considered to be matching best with the reality and hence, the area is identified with it (Mahmood, 1998).

**Table 6.15: Percentage wise distribution of average area for the period of three years (2013-14 to 2015-16) for eight (8) different crops of South District**

Sl.No.	Crops	Percentage of average area for three years (2013-14 to 2015-16)
1.	Maize	58.66
2.	Pulses	12.46
3.	Oilseeds	11.16
4.	Rice	8.28
5.	Buckwheat	5.86
6.	Finger-Millet	2.66
7.	Wheat	0.56
8.	Barley	0.36
	Total	100.0

Source: Compiled by Researcher.

Percentage wise distribution of average area for the period of three years (2013-14 to 2015-16) for eight (8) different crops of South district are calculated following Weaver's method to identify the significant crops of the district.

#### *One Crop*

Hypothetical%	100	Summation
Observed%	58.66	
Difference	41.34	
$d^2$	1708.99	
$d^2/n$	1708.9	

#### *Two Crops*

Hypothetical%	50	50	Summation
Observed%	58.66	12.46	
Difference	-8.66	37.54	
$d^2$	74.99	+1409.25	
$d^2/n$			

#### *Three Crops*

Hypothetical%	33.3	33.3	33.3	Summation
Observed%	58.66	12.46	11.16	
Difference	-25.36	20.84	21.7	
$d^2$	643.12	+435.31	+470.89	
$d^2/n$				

***Four Crops***

Hypothetical%	25	25	25	25	Summation
Observed%	58.66	12.46	11.16	8.28	
Difference	-33.66	12.54	13.84	16.72	
$d^2$	1132.99	+157.25	+191.55	+279.56	
$d^2/n$					

***Five Crops***

Hypothetical%	20	20	20	20	20	Summation
Observed%	58.66	12.46	11.16	8.28	5.86	
Difference	-38.66	7.54	8.84	11.72	14.14	
$d^2$	1494.59	+56.85	+78.12	+137.35	+199.94	
$d^2/n$						

***Six Crops***

Hypothetical %	16.66	16.66	16.66	16.66	16.66	16.66	Summation
Observed%	58.66	12.46	11.16	8.28	5.86	2.66	
Difference	-42	4.2	5.5	8.38	10.8	14	
$d^2$	1764	+17.64	+30.25	+70.22	+116.64	+196	
$d^2/n$							

***Seven Crops***

Hypothetical %	14.28	14.28	14.28	14.28	14.28	14.28	14.28	Summation
Observed %	58.66	12.46	11.16	8.28	5.86	2.66	0.56	
Difference	-44.38	1.82	3.12	6.00	8.42	11.62	13.72	
$d^2$	1969.58	+3.31	+9.73	+36.00	+70.89	+135.02	+188.23	
$d^2/n$								

***Eight Crops***

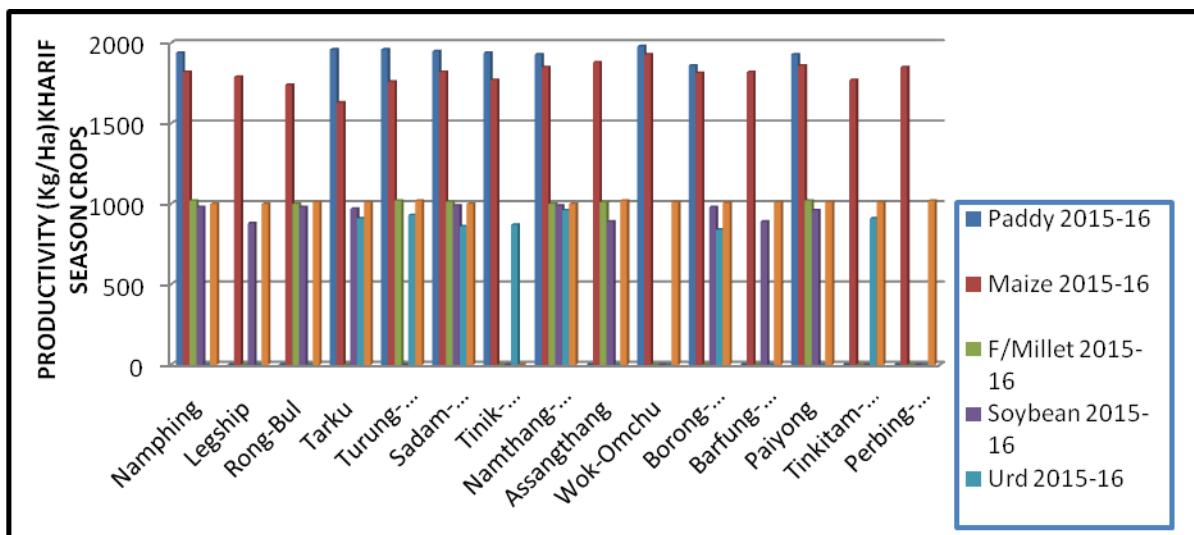
Hypothetica 1 %	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	Summatio n
Observed %	58.66	12.46	11.16	8.28	5.86	2.66	0.56	0.36	
Difference	-46.16	0.04	1.34	4.22	6.64	9.84	11.94	12.14	
d <sup>2</sup>	2130.75	+0.0016	+1.79	+17.81	+44.09	+96.82	+142.56	+147.38	=2581.19
d <sup>2</sup> /n									322.65

According to Weaver's method of crop combination, the South district may therefore be identified as a six to eight crops region and maize as the most dominating crop followed by pulses, oilseeds, rice and remaining four crops region (as the value of the index is lowest) of buckwheat, finger-millet, wheat and barley.

**Table 6.16: Productivity (Yield Kg/Ha) of Kharif Season Crops in Study Areas 2015-16**

Sl. No	Name of GPU's	Paddy	Maize	F/Millet	Soybean	Urd	Other Pulses
		2015-16	2015-16	2015-16	2015-16	2015-16	2015-16
1.	Namphing	1940	1820	1020	980	0	1000
2.	Legship	0	1790	0	880	0	1000
3.	Rong-Bul	0	1740	1000	980	0	1010
4.	Tarku	1960	1630	0	970	910	1010
5.	Turung-Mamring	1960	1760	1020	0	930	1020
6.	Sadam-Suntaley	1950	1820	1012	990	860	1000
7.	Tinik-Chisopani	1940	1770	0	0	870	0
8.	Namthang-Maneydara	1930	1850	1000	990	960	1000
9.	Assangthang	0	1880	1010	890	0	1020
10.	Wok-Omchu	1980	1930	0	0	0	1010
11.	Borong-Phamthang	1860	1814	0	980	840	1007
12.	Barfung-Zarung	0	1820	0	890	0	1010
13.	Paiyong	1930	1860	1020	960	0	1010
14.	Tinkitam-Rayong	0	1770	0	0	910	1010
15.	Perbing-Dovan	0	1850	0	0	0	1020

Source: Progress Report 2015-16.



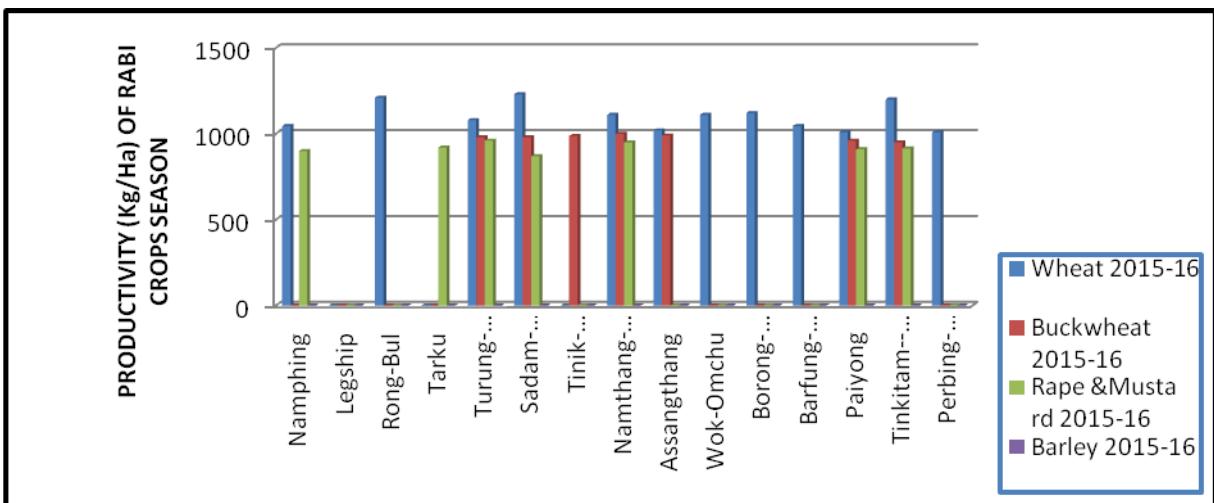
**Figure 6.6:** Productivity (Yield Kg/Ha) of Kharif Season Crops of the Study areas of South District (2015-16)

The above table 5.16 shows productivity pertaining to kharif crops which indicates paddy and maize to be predominant in almost all the study areas. Productivity of other crops such as finger-millet, soybean, urd and other pulses are almost in the same line in every study area. Among 15 GPUs only two GPUs i.e. Sadam-Suntaley and Namthang-Maneydara have grown all kharif crops. Similarly crop i.e. maize is grown in every study area.

**Table 6.17: Productivity (Yield Kg/Ha) of Rabi Season Crops in Study Areas 2015-16**

Sl. No.	Name of GPU's	Wheat	Buckwheat	Rape & Mustard	Barley
		2015-16	2015-16	2015-16	2015-16
1.	Namphing	1045	0	900	0
2.	Legship	0	0	0	0
3.	Rong-Bul	1210	0	0	0
4.	Tarku	0	0	920	0
5.	Turung-Mamring	1080	980	960	0
6.	Sadam-Suntaley	1230	980	870	0
7.	Tinik-Chisopani	0	987	0	0
8.	Namthang-Maneydara	1110	1000	950	0
9.	Assangthang	1020	990	0	0
10.	Wok-Omchu	1110	0	0	0
11.	Borong-Phamthang	1120	0	0	0
12.	Barfung-Zarung	1045	0	0	0
13.	Paiyong	1010	960	910	0
14.	Tinkitam-Rayong	1200	950	915	0
15.	Perbing-Dovan	1010	0	0	0

Source: Progress Report 2015-16.



**Figure 6.7:** Productivity (Yield Kg/Ha) of Rabi Season Crops of study areas (2015-16)

The above table 5.17 shows productivity pertaining to rabi crops which indicates wheat as the predominant crop followed by buckwheat and rape & mustard. The above data shows no GPU's have grown rabi crop like barley. Among 15 GPU's only 5 GPU's i.e. Turung-Mamring, Sadam-Suntaley, Namthang-Maneydara, Paiyong and Tinkitam--Rayong have cultivated all crops except barley. Some GPU's do not grow crops like wheat, buckwheat, rape & mustard.

### Horticulture in Sikkim

Sikkim enjoys certain privileges as far as horticulture is concerned. The range of sub-tropical to cold -temperate climate in the state has favoured cultivation of a wide variety of fruits, vegetables, root and tuber crops, spices and flowers. Sikkim is a prolific grower of fruits like mandarin orange, plum, peach, pear, avocado, guava, banana etc., vegetables such as, cabbage, cauliflower, pumpkin, bitter gourd, cucumber, tomato, a large variety of beans and leafy vegetables, and root and tuber crops, viz. potato, radish, carrot, turnip, cassava, sweet potato, yams, etc. Among the spices grown in Sikkim, large cardamom is by far the most important. Other than cardamom, ginger and turmeric are also grown profusely (Choudhury, 2006).

In relation to horticultural crops, the area covered by spices is maximum as per the report of 2015-16. Large cardamom alone accounts for 17.55 thousand ha. The crop has significant place in Sikkim's agro forestry. Cardamom plants grow well in places with lot of shade and ground moisture. Most of the cardamom plantations are accompanied by the forests particularly of a local species called Uttis (*Alnus Nepalensis*).

In contrast to cardamom, other crops like ginger and turmeric are grown in comparatively dry and open areas. Apart from these Asiatic spices, exotic spices like basil, thyme, oregano and parsley are also being tried on Sikkim soil on experimental basis. The fruit orchards in Sikkim

cover about 6 thousand ha out of which orange orchards account for 4.25 ha. As for production, the vegetables rank first due to the bulk of the produce. The spices occupy the second place while potato and other tubers comes a close third, followed by fruits (Choudhury, 2006).

The conventional method of agriculture in Sikkim households has a diversity of horticultural crops which append significant amount of income to the marginal farmers. Horticulture is nowadays gaining popularity for domestic consumption as well as marketability. Over the last one decade the concept has been changed from traditional to commercial horticulture and it is introduced in Sikkim in order to enhance socio-economic status. Horticulture in the state generally consists of mandarin orange, passion fruit, pear, kiwi etc., vegetables such as beans, garden pea tomato, cabbage, carrot, radish, chayote, tuber crops etc., spice crops such as large cardamom, ginger, turmeric, cherry pepper (dale khorsani/fire ball) and flowers.

Horticultural crops such as large cardamom, ginger and mandarin orange are the main cash crops which support the ecology and agro-climatic conditions of Sikkim. Fruit trees play a vital role in the agroforestry systems, farmlands, and home-gardens too. The above crops are basically important for their socio-economic values, and also for building up pliability to changes in the case of agro-ecosystems. Local growers of cardamom, mandarin and ginger are commercially exploited and can only just be replaced by any other newly introduced commercial farming systems.

Horticulture is one of the chief economic activities of the people of Sikkim. Large cardamom, ginger and turmeric are the principal spice crops, while mandarin orange, guava, mango, banana and so on are the principal fruits grown in the state. The department of Horticulture is deeply involved in motivating and providing technical guidance to local farmers. Sikkim is also famous for flowers. Gladioli, anthuriums, lilliums, primulas, rhododendrons, orchids as well as many other floral species thrive here. The state is home to an amazing 450 species of exotic orchids alone. There is immense potential for developing floriculture on a commercial basis here, and the department of horticulture is making concerted efforts to turn this sector into an export-oriented industry ([sikkim.nic.in](http://sikkim.nic.in)).

Sikkim has penetrated in new era of serious development after the remarkable constitutional change of April 1975; then state joined the mainstream of national life after becoming the 22<sup>nd</sup> State of Indian Union. The government decided to implement the policy of development with sustainability, making horticulture a main concern sector for higher income generation to farming community as well as to give attention to maximum crop production of agricultural crops and supervision primarily on agro-resources like soil, water and bio-diversity. Incorporated farming, an ideally appropriate system, is commonly followed by farmers in the State, which carries the potential to change the developmental process by making Sikkim an organic state. Sikkim was declared as the first fully Organic State of India on January 2016,

after the announcement made by Prime Minister of India Shri Narendra Modi. As a corollary to the Chief Minister's announcement of November, 2017, vegetables grown inorganically, outside the state have been banned in Sikkim after 31<sup>st</sup> March, 2018.

Livelihoods of about 80 percent people of the state are directly or indirectly dependent on scarce land resources. Engagement in practicing horticulture will boost state's domestic product that will have important implications. The horticulture sector receives priority attention for higher levels of rural prosperity. Horticulture crops play a distinctive role in Sikkim as well as in India's economy by improving the income status of the rural people. Cultivation of horticulture crops is labour intensive and as such they create a number of employment opportunities for the rural population. Basically, fruits and vegetables have high source of vitamins, minerals, proteins carbohydrates, etc. and are essential to every human being. Hence, these are referred to as defending foods and implicit great importance as nutritional security for the people.

Cash and commercial crops like large cardamom, ginger, orange, seed potato, flower and off-season vegetables along with other horticultural crops (varieties of fruits, root and tuber crops, mushroom, honey, nuts, spice crops like turmeric, seed spices etc., medicinal and aromatic plants) are dealt by the Horticulture & Cash Crops Development Department since its creation in 1996 ([www.visva-bharati.ac.in](http://www.visva-bharati.ac.in)).

The scheme of Horticulture Mission for North East and Himalayan States (HMNEH) stands as a back bone of horticulture development in Sikkim as through it there has been a considerable enhancement in funding and amendment in pattern of assistance than earlier. The basic aims of the Mission is to achieve horizontal and vertical combination of horticultural programmes to enhance production, by providing appropriate timely and concurrent attention to all associated in production, post-harvest management and consumption sequence to maximize economic, ecological and social benefits to the people.

### **Horticulture Transformation**

Sikkim's diverse ecological conditions ranging from tropical to alpine support the cultivation of a variety of fruits, vegetables, in and out of season, and are also excellent for commercial crops like cardamom, ginger, orange, etc. The present trends towards rapid expansion of horticultural crops will have positive implications for improving food and economic security of the farmers of Sikkim. However, perusal of yield data and other parameters like net income per ha, market demand, peak season of arrivals and price trend in major markets should be kept in mind to regulate the production-marketing chain. Ginger, Vegetable farming, seed potato farming in horticulture and also livestock rearing especially dairying has particularly helped small and marginal farmers of Sikkim to come out of poverty trap. The concern of such

small and marginal farmers today is sustainability of the option and not the alternative (Subba, 2008).

The NABARD has funded the project like Bagan Development Project (WADI) which was implemented by Krishi Vigyan Kendra (KVK) of South Sikkim. It mainly focuses on tribal villages of South district under the Agro-climatic zones which is highly appropriate for persistent plantation of fruits like orange, guava and lemon at the low altitude. According to this project some subsidy has been given to tribal villagers for the plantation of horticultural crops. Moreover, the central part of WADI programme is a wider developmental project in order to create a sustainable living with the “Tree Based Farming System”. In the core part, the programme evolves and shapes into a complete effort that deals with short term and long term need in the course of array of mechanism for managing a natural resource and develop varied source of income and help for the improvement of quality of life.

The Bagan Development Project (WADI) mainly targets to cover total 400 households as well as 400 acres of land taken up in two phases. The project is being implemented in tribal villages of South Sikkim and its adjoining area i.e. Namthang covering 400 acres of land and around 400 tribal households have been benefited - 96 households at Lower Kateng Bokrang, Upper Kateng, Bokrang - 50 households, 40 households in Palitam-Ruchung, Kabrey - 80 households, Rabikhola - 36 households, Rabitar - 48 households and Manghim - 50 households.. In the 1<sup>st</sup> Phase only 150 households were taken up and in 2<sup>nd</sup> Phase remaining 250 households were covered.

### **Horticultural Crop Production**

Production is a cumulative term involving the implications of various material inputs and immaterial inputs in order to produce something for consumption.

**Table 6.18: Horticultural Crops Production in Sikkim (1975-76 to 1995-96)**

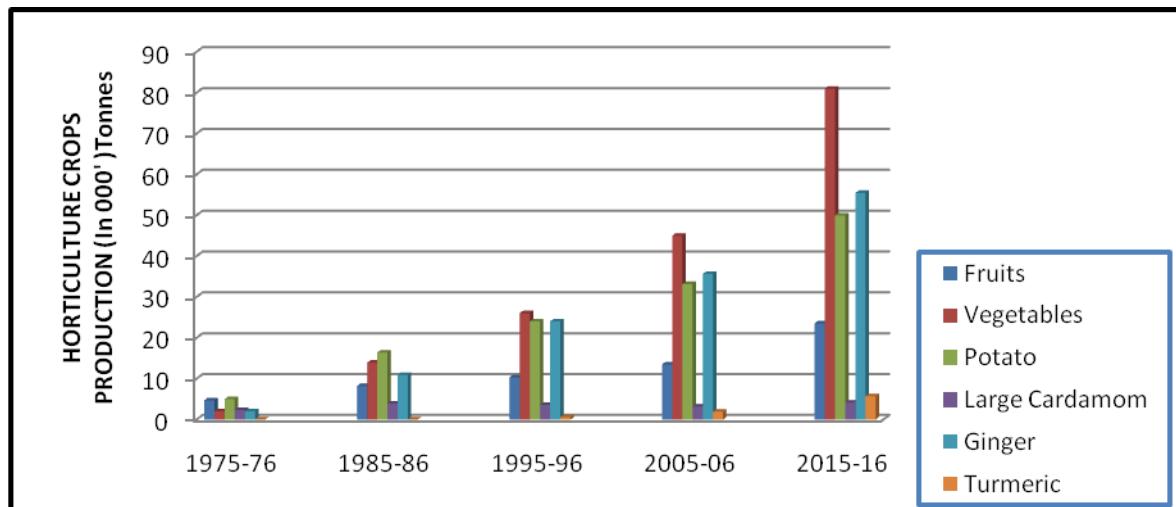
Sl. No.	Crops	1975-76 Mean ± S.D.	Standar d Error	1985-86 Mean ± S.D.	Standar d Error	1995-96 Mean ± S.D.	Standar d Error
1.	Fruits	4.70±3.0216	1.2335	8.20±6.4807	2.6457	10.30±6.6932	2.7325
2.	Vegetable s	2.00±1.1189	.4568	13.90±7.8230	3.1937	26.00±12.6332	5.1575
3.	Potato	5.00±2.8816	1.1764	16.40±8.1486	3.3266	24.00±10.2761	4.1952
4.	Large Cardamo m	2.30±1.3589	.5547	3.90±2.2387	.91339	3.60±2.4404	.9963
5.	Ginger	2.00±1.1189	.4568	10.90±6.6030	2.6956	24.00±10.2761	4.1952
6.	Turmeric	000	000	000	000	0.60±.2423	.0989

Source: Gazetteer of Sikkim-2013, Office Record (Horticulture Department)-2015-16.

**Table 6.19: Horticultural Crops Production of Sikkim (2005-06 to 2015-16)**

Sl. No.	Crops	2005-06 Mean ± S.D.	Standard Error	2015-16 Mean ± S.D.	Standard Error
1.	Fruits	13.47±8.1731	3.3366	23.53±9.9398	4.0579
2.	Vegetables	44.97±19.9699	8.1527	80.96±30.3842	12.4043
3.	Potato	33.14±14.9398	6.0991	49.93±20.9284	8.5440
4.	Large Cardamom	3.16±2.3004	.9391	4.12±3.0331	1.2382
5.	Ginger	35.63±15.6588	6.3927	55.45±25.7449	10.5103
6.	Turmeric	1.91±1.3311	.5434	5.68±3.8987	1.5916

Source: Gazetteer of Sikkim-2013, Office Record (Horticulture Department)-2015-16.



**Figure 6.8: Horticultural Crops Production of Sikkim (1975-76 to 2015-16) In 000' Tons**

The above tables (6.18 & 6.19) depict horticultural crops production of Sikkim from (1975-76 to 2015-16) in 000' tons which shows the significant mean  $\pm$ S.D. and standard error of six different horticultural crops such as fruits, vegetables, potato, large cardamom, ginger and turmeric. Among the different horticultural crop production, vegetables have the highest production and it is rising in every decade from 1985-86 to 2015-16 with mean  $\pm$ S.Ds in 1985-86 ( $13.90\pm7.8230$ ), 1995-96 ( $26.00\pm12.6332$ ), 2005-06 ( $44.97\pm19.9699$ ) and 2015-16 ( $80.96\pm30.3842$ ) and their corresponding errors are calculated as 1985-86 (3.1937), 1995-96 (5.1575), 2005-06 (8.1527) and 2015-16 (80.96±30.3842). But in 1975-76 vegetables production was not up to the mark, it went down compared to fruits and potato. Ginger comes after vegetables and it is also rising in every decade from 1995-96 to 2015-16, having the following mean  $\pm$ S.Ds: 1995-96 ( $24.00\pm10.2761$ ), 2005-06 ( $35.63\pm15.6588$ ) and 2015-16 ( $55.45\pm25.7449$ ) and the corresponding errors are calculated 1995-966 (4.1952), 2005-06

(6.3927) and 2015-16 (10.5103). Ginger had low production in 1975-76 and 1985-86 compared to potato. The third position is held by potato and it is rising in every decade from 1975-76 to 2015-16 and the mean  $\pm$ S.Ds are: 1975-76 ( $5.00 \pm 2.8816$ ), 1985-86 ( $16.40 \pm 8.1486$ ), 1995-96 ( $24.00 \pm 10.2761$ ), 2005-06 ( $33.14 \pm 14.9398$ ) and 2015-16 ( $49.93 \pm 20.9284$ ) and their corresponding errors calculated as 1975-76 (1.1764), 1985-86 (3.3266), 1995-966 (4.1952), 2005-06 (6.0991) and 2015-16 (8.5440). The production of every horticulture crops since 1975 up to 2016 may be credited to governmental initiatives and rigorous practicing and actualization of its policies.

### **Horticultural Crop Productivity**

Crop productivity is a multi-dimensional concept, which includes technological advancement, effective management of available resources, and organizational setup for crop production. These factors in turn affect the relative crop production in the region. It may be pointed out, that the development of agriculture should be assessed by evaluating the use of various inputs i.e., the extent of cultivated area, provision of irrigation, fertilizers, improved varieties of seeds and labour availability. It provides food for growing population and helps to extend the secondary and tertiary sectors, increases the income, and provide welfare to the population living in rural areas.

**Table 6.20: Horticulture Crops Productivity of Sikkim (1975-76 to 1995-96) In Kg/Ha**

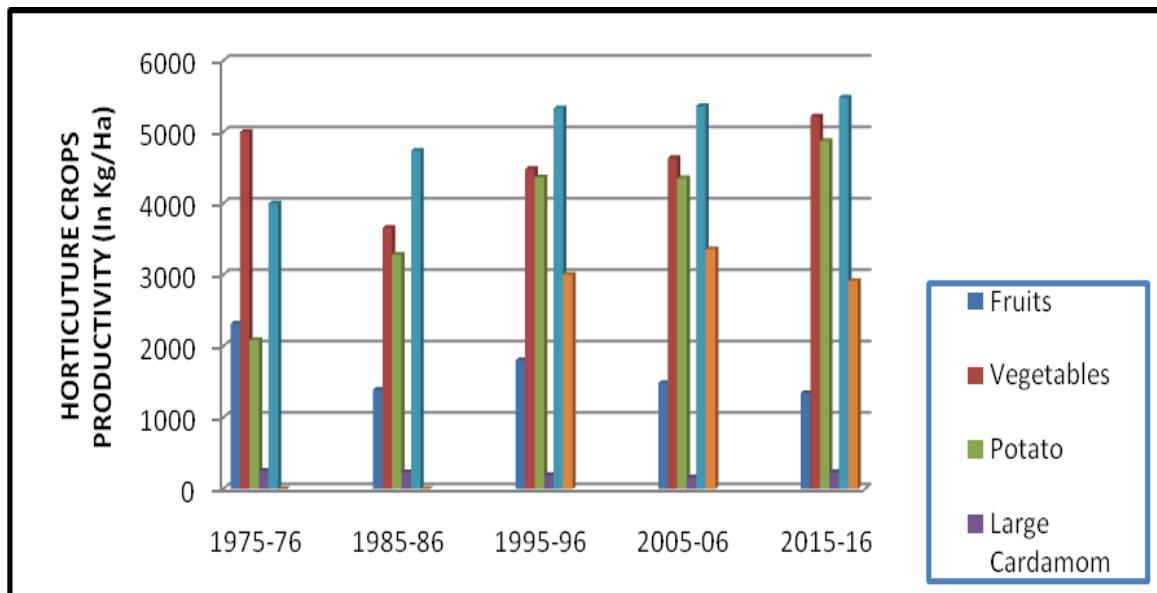
Sl. No.	Crops	1975-76 Mean $\pm$ S.D.	Standard Error	1985-86 Mean $\pm$ S.D.	Standard Error	1995-96 Mean $\pm$ S.D.	Standard Error
1.	Fruits	$2315 \pm 14.9264$	6.0937	$1391 \pm 21.7899$	8.8956	$1803 \pm 22.8735$	9.3380
2.	Vegetables	$5000 \pm 23.1257$	9.4410	$3657 \pm 205718$	8.3984	$4482 \pm 28.0214$	11.4397
3.	Potato	$2083 \pm 30.3512$	12.3908	$3280 \pm 22.5920$	9.2231	$4363 \pm 22.5831$	9.2195
4.	Cardamom	$255 \pm 26.0076$	10.6176	$233 \pm 15.2970$	6.2450	$191 \pm 22.4321$	9.1578
5.	Ginger	$4000 \pm 22.9782$	9.3808	$4739 \pm 20.149$	8.2259	$5333 \pm 16.8404$	6.8750
6.	Turmeric	000	00	000	000	$3000 \pm 19.6875$	8.0374

Source: Gazetteer of Sikkim-2013, Office Record (Horticulture Department)-2015-16.

**Table 6.21: Horticulture Crops Productivity of Sikkim (2005-06 to 2015-16) In Kg/Ha**

Sl. No.	Crops	2005-06 Mean $\pm$ S.D.	Standard Error	2015-16 Mean $\pm$ S.D.	Standard Error
1.	Fruits	1483 $\pm$ 30.4827	12.4445	1342 $\pm$ 21.7071	8.8619
2.	Vegetables	4633 $\pm$ 16.8641	6.8847	5218 $\pm$ 21.3447	8.7139
3.	Potato	4350 $\pm$ 21.8174	8.9069	4873 $\pm$ 20.7171	8.4577
4.	Cardamom	158 $\pm$ 16.8166	6.8653	235 $\pm$ 27.5971	11.2664
5.	Ginger	5363 $\pm$ 25.4165	10.3762	5482 $\pm$ 29.4482	12.0222
6.	Turmeric	3357 $\pm$ 23.5796	9.6263	2914 $\pm$ 20.7171	8.4577

Source: Gazetteer of Sikkim-2013, Office Record (Horticulture Department)-2015-16.



**Figure 6.9: Horticulture Crops Productivity of Sikkim (1975-76 to 2015-16) In Kg/Ha**

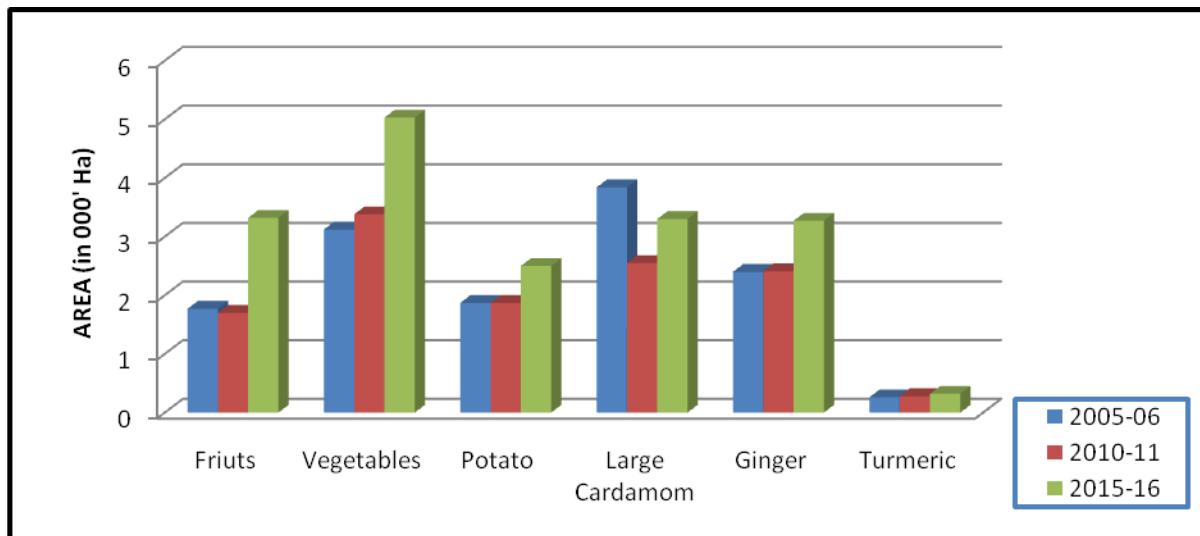
The tables (6.20 & 6.21) and figure illustrate horticulture crops productivity of Sikkim from (1975-76 to 2015-16) in kg/ha. Among the different horticultural crops, vegetables have seen highest productivity in 1975-76 with the mean  $\pm$ S.D. is  $5000 \pm 23.1257$  and its corresponding error is calculated as 9.4410. But the overall highest productivity has been seen in ginger and it is continuously increasing from 1975-76 ( $4000 \pm 22.9782$ ), 1985-86 ( $4739 \pm 20.149$ ), 1995-96 ( $5333 \pm 16.8404$ ), 2005-06 ( $5363 \pm 25.4165$ ) and 2015-16 ( $5482 \pm 29.4482$ ) and their corresponding errors are calculated as 1975-76(9.3808), 1985-86 (8.2259), 1995-96 (6.8750), 2005-06 (10.3762) and 2015-16 (12.0222). The second position is secured by ginger productivity and it is also rising in every decade from 1985-86 to 2015-16, the mean  $\pm$ S.D. 1985-86 ( $3657 \pm 205718$ ), 1995-96 ( $4482 \pm 28.0214$ ), 2005-06 ( $4633 \pm 16.8641$ ) and 2015-16

( $5218 \pm 21.3447$ ) and the corresponding errors are calculated 1985-86( $8.3984$ ), 1995-96 ( $11.4397$ ), 2005-06 ( $6.8847$ ) and 2015-16 ( $8.7139$ ). The third position is held by potato and it is rising in every decade from 1975-76 to 2015-16 and the mean  $\pm S.D.$  1975-76 ( $2083 \pm 30.3512$ ), 1985-86 ( $3280 \pm 22.5920$ ), 1995-96 ( $4363 \pm 22.5831$ ), 2005-06 ( $4350 \pm 21.8174$ ) and 2015-16 ( $4873 \pm 20.7171$ ) and their corresponding errors calculated as 1975-76 ( $12.3908$ ), 1985-86 ( $9.2231$ ), 1995-96 ( $9.2195$ ), 2005-06 ( $8.9069$ ) and 2015-16 ( $8.4577$ ). The production of two remaining crops such as fruits and large cardamom are much less. But the productivity of turmeric crop has been drastically increased from 1985-86 to 1995-96, then slightly decreased from 2005-06 to 2015-16.

**Table 6.22: Area of Major Horticultural Crops of South District (2005-06, 2010-11 and 2015-16) in 000' Ha**

Crops	2005-06 Mean $\pm S.D.$	Standard Error	2010-11 Mean $\pm S.D.$	Standard Error	2015-16 Mean $\pm S.D.$	Standard Error
Fruits	$1.77 \pm 1.1377$	.4645	$1.70 \pm .6899$	.2816	$3.32 \pm 2.1808$	.8903
Vegetables	$3.12 \pm 1.0564$	.4312	$3.38 \pm .2170$	.0886	$5.03 \pm 3.4641$	1.4142
Potato	$1.87 \pm 8.000$	.3266	$1.87 \pm .2348$	.0958	$2.50 \pm 1.3228$	.5400
Large Cardamom	$3.84 \pm .9316$	.3803	$2.55 \pm .1792$	.0731	$3.30 \pm 2.2871$	.9337
Ginger	$2.4 \pm 1.3084$	.5341	$2.41 \pm .2083$	.0850	$3.27 \pm 2.1475$	.8767
Turmeric	$0.26 \pm 1.554$	.0634	$0.28 \pm .0946$	.0886	$0.62 \pm .3875$	.1582

Source: DESME 2006-07 and Annual Progress Report 2010-11 & 2014-15.



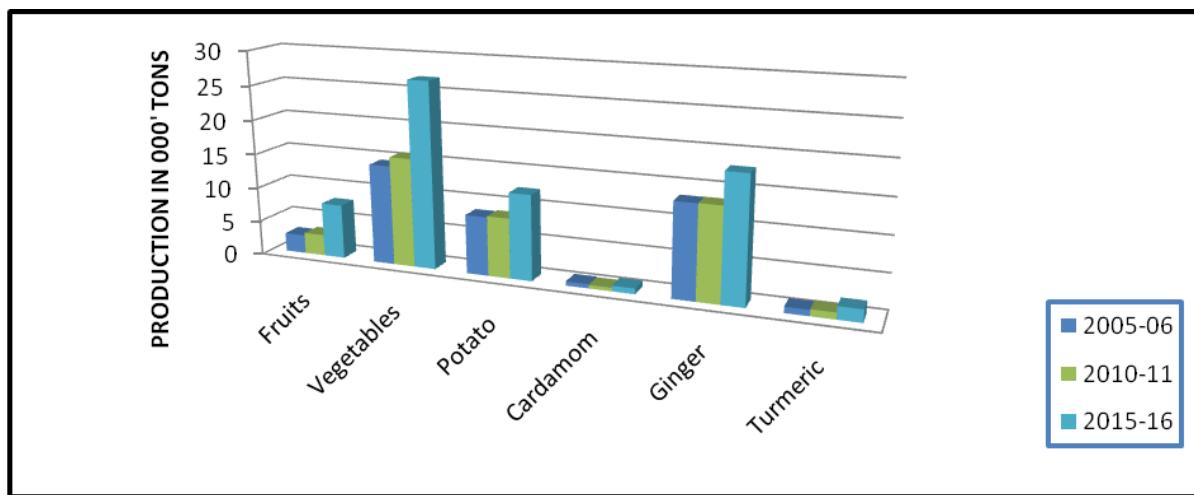
**Figure 6.10:** Area (in 000'ha) of major horticultural crops in South District (2005 to 2015-16)

The above table (6.22) shows the area under major horticultural crops in South district (2005-06, 2010-11 and 2015-16) and shows the significant mean  $\pm$ S.D. and standard error of six different crops such as fruits, vegetables, potato, large cardamom, ginger and turmeric. In case of large cardamom, the cultivated area was high in 2005-06, which decreased in 2010-11 but again increased in 2015-16. It has the mean  $\pm$ S.D.s. are 2005-06 ( $3.84\pm.9316$ ), 2010-11 ( $2.55\pm.1792$ ) and 2015-16 ( $3.30\pm2.2871$ ) and their corresponding errors calculated as 2005-06 (.3803), 2010-11 (.0731) and 2015-16 (.9337). The area under ginger crop is almost similar in 2005-06 and 2010-11, but it has suddenly increased in 2015-16. It has the mean  $\pm$ S.D. 2005-06 ( $2.4\pm1.3084$ ), 2010-11 ( $2.41\pm.2083$ ) and 2015-16 ( $3.27\pm2.1475$ ) and the corresponding errors are calculated 2005-06 (.5341), 2010-11 (.0850) and 2015-16 (.8767). The area under fruit and potato crops increased tremendously in 2015-16 compared to 2005-06 & 2010-11. The area of turmeric crop has been increasing consistently but at a slow pace. As per 2015-16 horticulture land use covers of South district is estimated to be around 18040 hectare about 2.54 percent of the total geographical area.

**Table 6.23: Production of Major Horticultural Crops of South District (2005-06, 2010-11 and 2015-16) - (in 000' Tons)**

Crops	2005-06 Mean $\pm$ S.D.	Standard Error	2010-11 Mean $\pm$ S.D.	Standard Error	2015-16 Mean $\pm$ S.D.	Standard Error
Fruits	$2.71\pm1.3130$	.5360	$3.08\pm.2085$	.0851	$7.90\pm4.4271$	1.8073
Vegetables	$14.41\pm6.6030$	2.6956	$15.74\pm.2137$	.0872	$26.89\pm7.5630$	3.0876
Potato	$8.47\pm5.9665$	2.4358	$8.63\pm.1947$	.0795	$12.28\pm8.4142$	3.4351
Cardamom	$0.61\pm.2160$	.0882	$0.51\pm.2007$	.0819	$0.81\pm.2886$	.1178
Ginger	$13.36\pm6.1644$	2.5166	$13.39\pm.2173$	.0887	$17.89\pm9.9398$	4.0579
Turmeric	$0.86\pm.3717$	.1517	$0.95\pm.2513$	.1026	$1.81\pm1.3928$	.5686

Source: DESME 2006-07 and Annual Progress Report 2010-11 & 2014-15.



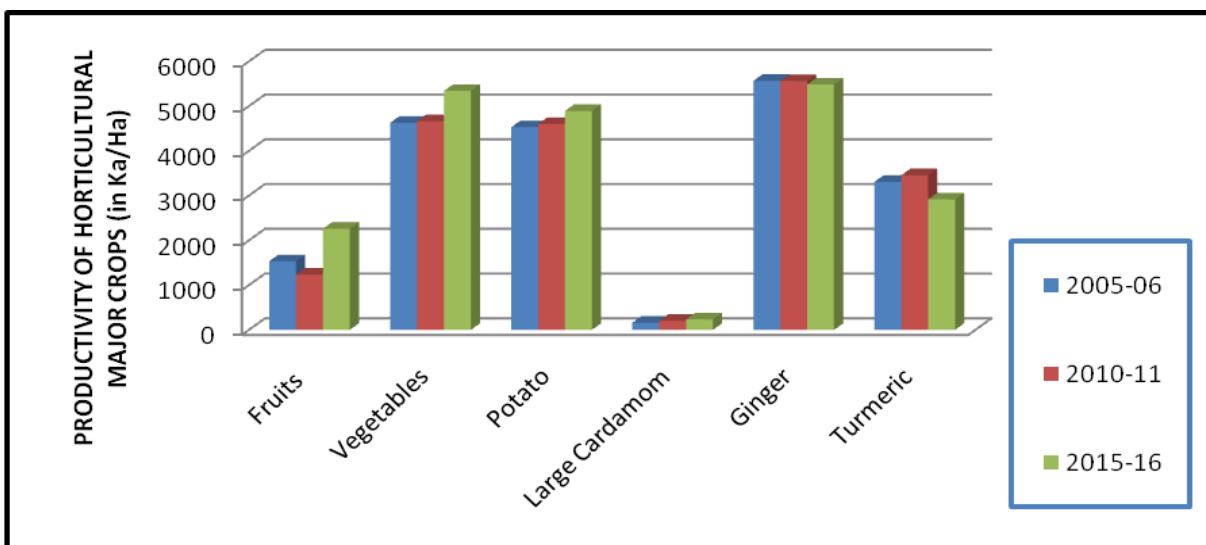
**Figure 6.11: Area (in 000'ha) of major horticultural crops in South District (2005 to 2015-16)**

The above table (6.23) illustrates production of major horticultural crops of South district (2005-06, 2010-11 and 2015-16). Amongst the different horticultural crops, production of vegetables is higher and has been increasing in every five years, but in 2015-16 production increased tremendously and it has mean  $\pm$ S.D.2005-06 ( $14.41\pm6.6030$ ), 2010-11 ( $15.74\pm2.2137$ ) and 2015-16 ( $26.89\pm7.5630$ ) and their corresponding errors are calculated as 2005-06 (2.6956), 2010-11 (.0872) and 2015-16 (3.0876) respectively. As far as production of ginger is concerned, it is almost similar in 2005-06 and 2010-11, but it has suddenly increased in 2015-16. It has the mean  $\pm$ S.D.2005-06 ( $13.36\pm6.1644$ ), 2010-11 ( $13.39\pm2.2173$ ) and 2015-16 ( $17.89\pm9.9398$ ) and the corresponding errors are calculated 2005-06 (2.5166), 2010-11 (.0887) and 2015-16 (4.0579) respectively. Potato production seems to be almost same in 2005-06 and 2010-11, but it has increased in 2015-16 and the mean  $\pm$ S.D.2005-06( $8.47\pm5.9665$ ), 2010-11 ( $8.63\pm1.1947$ ) and 2015-16 ( $12.28\pm8.4142$ ) and their corresponding errors calculated as 2005-06 (2.4358), 2010-11 (.0795) and 2015-16 (3.4351). The production of fruit has increased tremendously in 2015-16 compared to 2005-06 & 2010-11. The productions of turmeric and large cardamom crops have been increasing consistently but at a slower pace.

**Table 6.24: Productivity of Major Horticultural Crops of South District (2005-06, 2010-11 & 2015-16) - (in Kg/Ha)**

Crops	2005-06 Mean $\pm$ S.D.	Standard Error	2010-11 Mean $\pm$ S.D.	Standard Error	2015-16 Mean $\pm$ S.D.	Standar d Error
Fruits	$1534\pm19.6977$	8.0415	$1237\pm18.2537$	.7420	$2261\pm24.9719$	10.1947
Vegetables	$4627\pm15.3883$	6.2822	$4663\pm19.1206$	7.8059	$5340\pm21.3447$	8.7139
Potato	$4528\pm14.5327$	5.9329	$4600\pm26.1457$	10.6739	$4892\pm19.6672$	8.0291
Cardamom	$160\pm22.6715$	9.2556	$201\pm23.3152$	9.5184	$234\pm16.3340$	6.6683
Ginger	$5565\pm26.2526$	10.7175	$5560\pm26.3438$	10.7548	$5482\pm29.4482$	12.0222
Turmeric	$3308\pm21.4755$	8.7673	$3456\pm21.8632$	8.9256	$2915\pm17.5271$	7.1554

Source: DESME 2006-07 and Annual Progress Report 2010-11 & 2014-15.



**Figure 6.12:** Area (in 000' Kg/Ha) of Major Horticultural Crops in South Sikkim (2005 to 2015-16)

The table (5.24) depicts the Productivity of major horticultural crops of South district (2005-06, 2010-11 and 2015-16). Among the different horticultural crops, productivity of vegetables has been increasing at regular intervals, but in 2015-16 productivity increased greatly and it has mean  $\pm$ S.D. 2005-06 ( $4627 \pm 15.3883$ ), 2010-11 ( $4663 \pm 19.1206$ ) and 2015-16 ( $5340 \pm 21.3447$ ) and their corresponding errors are calculated as 2005-06 (6.2822), 2010-11 (7.8059) and 2015-16 (8.7139) respectively. Productivity of ginger is almost similar in 2005-06 and 2010-11, but it has slightly decreased in 2015-16. It has the mean  $\pm$ S.D. 2005-06 ( $5565 \pm 26.2526$ ), 2010-11 ( $5560 \pm 26.3438$ ) and 2015-16 ( $5482 \pm 29.4482$ ) and the corresponding errors are calculated 2005-06 (10.7175), 2010-11 (10.7548) and 2015-16 (12.0222) respectively. Likewise, productivity of potato seems to be slightly increasing from 2005-06, 2010-11 and 2015-16 and the mean  $\pm$ S.D. 2005-06 ( $4528 \pm 14.5327$ ), 2010-11 ( $4600 \pm 26.1457$ ) and 2015-16 ( $4892 \pm 19.6672$ ) and their corresponding errors calculated as 2005-06 (5.9329), 2010-11 (10.6739) and 2015-16 (8.0291). The productivity of turmeric and fruits crops have been fluctuating, but the productivity of large cardamom crop has been increasing gradually.

#### **Area Expansion Programme of 2015-16, Department of Horticulture and Cash Crops, South district**

##### ***Fruits***

Some of the vital fruits like, mandarin orange, guava, papaya, banana and litchi have started growing on commercial basis in the state.

##### ***Mandarin orange***

Sikkim Mandarin is one of the chief fruit crop having great commercial possibility. Various biotic and abiotic factors determine the production and productivity of orange. During Area

Expansion Programme many new orchards came up in villages like Sadam, Chisopani, Boomtar, Ruchung , Rateypani, Lamaten, Suntaley, Nalick, Tingmoo Kritipur,, Kamargoan, Dhargoan, Mamley, Gagyong, Zarrong, Sripatam and Anethang. According to Progress Report of 2014-15, under the Area Expansion Programme many new villages are aimed to cover, the villages include, Kamrang, Pabomg, Sumbuk, Tingley, Yangang, Lingi, Lingding, Turuk, Rabikhola, Chalamthang, Todey and Wok. The impact of Area Expansion Programme is evidently observed in mandarin fruit as a result of tremendous encouragement it received. In association with HCCDD and RMDD plantation of oranges is done as per the manual.

### ***Orange replenishment***

South district has a significant place where one of the important fruit crops like mandarin orange can grow. It is mainly grown in regions such of Turuk, Yangang, Tirikhola, Rateypani, Lingi, Lingmoo, Tingley, Rabitar, Kamrang, Pabong, Sumbuk, Todey and Tarku. However, because of the ageing of the trees, lesser care, and dominance of diseases and insect-pests, many orchards have become less productive and are in a declining phase. Such orchards are being revived in a phase wise manner. The beneficiaries have been provided with some crucial inputs after giving the training by utilizing the service of subject expert on the spot. These measures may bring hope and encourage farmers which would have a bearing on rejuvenation of the orchards and thereby augmentation in the production of the fruits.

### ***Guava***

The horticulture department has initiated to distribute guava seedlings at low elevation areas of Aifaltar, Namlung, Kamrang, Kitam, Pabong, Chalamthang, Barfung , Turuk and Kateng. High density planting of guava varieties such as Allahabad safeda and L-49 has been found booming in Turuk, Bermoiok, and Chalamthang. According to the Progress Report of 2014-15 under the Area Expansion Programme many new villages such as, Turuk, Dong, Mellidara, Wok, Sumbuk, Lingi, Lingmoo, Tarku, Salghari, Zarong and Lingzo have been included. Guava also is included in junction programme.

### ***Litchi***

The farming of litchi crop has been started at Samatar, Sikip, Lower Goam, Belbotey of Rabong Sub-Division. As per Progress Report of 2014-15 the Area Expansion Programme has incorporated many new villages like, Kitam, Wok and Namthang of Namchi sub-division whereas Bermiok and Chalamthang come under Rabong sub-division under the scheme.

### ***Papaya***

Papaya seedlings are being distributed by the department to the progressive farmers in selected areas like Donak, Niya Brum, Lower Kateng and Turuk.

### **Banana**

Banana suckers has been distributed by the department to the farmers in different places such as Kamrang, Lungkhiya, Samatar, Lower Kateng, Rong, Mainabotey, Lower Kabrey, Upper Pamphok, Pakjer and Nalick.

### **Vegetables**

As far as the vegetables production is concerned South district stands at 1<sup>st</sup> position in the state. The remarkable improvement has been seen in vegetable production in the district. During the main seasons, vegetables are grown in more or less all area of South district. On the other hand, department always encourages the farmers to produce vegetables either early, late or in off-season so as to obtain a good market price. Some of the villagers are popular in particular commercial vegetables farming such as bottle-gourd of Pakzor, Chumlik and Samatar, Rong, Turuk, Passi-Rateypani, Lungchok-Pabong and Niya. Tomato of Sadam, Phongla, Tinzir, Cauliflower of Simkharka, Diu, Temi-Tarku and Chubba-Perbing, cabbage and broccoli of Salleybong and Chisopani, Carrot, Palak, Bhindi, Letuce of Chisopani and Samatar, Green peas of Rabong, Ghurpisay, Perbing and Temi.

Off-season cabbages are mostly produced at Khop, Perbing, Jaubari and Diu-Damthang areas and are economically very lucrative. The areas such as Perbing and Jaubari are the producers of radish, palak and coriander throughout the year. The places like Bikmat, Ramaram, Sadam and Suiram are famous for early season iskush (chayote) are produced by the farmers which obtains better price at local areas as well as outside the state. Recently, South district has been producing significant amount of off-season vegetables like cabbage, tomato and cauliflower. The positive impact of scheme on vegetable production has been seen because more farmers have been benefitted. Consequently, many farmers' livelihoods are based on vegetable farming.

### **Large cardamom**

Large cardamom is one of the important cash crops of South district. In fact, it is the native crop of local farmers of high elevation areas. Generally, cardamoms are planted in agro-forestry milieu and it thrives well due to its shade loving environment. Many aged and fruitless cardamom orchards still has a place which needs to be uprooted to establish new orchards. The arrangement of complete removal of aged and ailing plants followed by composting of biomass has to be followed continuously, and in a phase wise manner. After the convergence with RMDD since 2014, the plantation of cardamom has been done extensively. The Horticulture and Cash Crops Department, Government of Sikkim in collaboration with MGNREGS scheme started distributing cardamom (sawaney, bharlang etc.) seedlings/plantings in the month of July 2016 to the interested and progressive farmers. It had distributed seedlings of cardamom free of cost to the farmers the numbers of seedlings ranging

between 200-1000 sticks to every family according to their needs and demands in south Sikkim.

### **Ginger**

Ginger is one of the main spice crops of South district, which is grown in nearly all the parts, within in mid and low altitude areas. Healthy planting resources are made accessible to the farmers from the certified seeds growers under ginger seed village scheme. For many farmers' livelihood, ginger has significant role in establishing itself as a main sources of income. Positive impact of the Area Expansion Programme has been observed in ginger cropping thereby, benefitting many poor farmers.

### **Turmeric**

The Horticulture and Cash Crop Department has initiated large level farming of turmeric since last few years. But recently, a turmeric seed has been distributed to the farmers in a ratio of about 1 acre of land to 4 monds (40kgs) of seed for cultivation purpose. As a result, many farmers are cultivating this crop with full interest and enthusiasm. New variety called Roma and Lakadang is being promoted in the district. The achievements of these varieties are good. Turmeric crop might replace ginger in lower altitude.

### **Transfer of Technology**

Training to farmers is one of the important programmes under transfer of technology. Farmers training programmes is the regular feature of the department. Crop specific trainings programmes are conducted at project area in class room environment. With the introduction of new technology, need of imparting training and creating awareness among the farming communities is must. The response from the farmers on training within the state and outside the state is very encouraging .More and more progressive farmers are coming forward to take training in and outside state, especially for floriculture, off-season vegetables and vegetables cultivation in protected condition (Annual Progress Report-2012-13, HCCDD, South Sikkim). Cash and commercial crops like large cardamom, ginger, orange, seed potato, flowers and off-season vegetables along with other horticultural crops (varieties of fruits, root and tuber crops, mushroom, honey, nuts, spice crops like turmeric, seed spices etc, medicinal and aromatic plants) are dealt by the Horticulture & Cash Crops Development Department since its creation in 1996.

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