CHAPTER I

INTRODUCTION

Modernisation and globalisation of agriculture demands appropriate machinery for enhancing resource use efficiency and productivity. Indian Agriculture has made tremendous progress in food production that, by 1970-71 our food grain production was doubled from that of 1950-51 and it has reached 217 million tonnes in 2008-09. As a consequence of the developments, India was able to achieve relatively self sufficiency in food grains and had made remarkable progress in oil seed and dry fanning agriculture. There are still many thrust areas in which India must now orient its policies in the interest of agricultural growth with special emphasis on sustainability and equity. One such thrust area is to boost the productivity of horticultural crops with particular emphasis on economically important crops like spices which earn sizable foreign exchange for the country.

1.1. Spices - **foreign exchange earner**

Spices including seed spices along with end products like spice oils and oleoresins are fetching considerable foreign exchange. The global market for spices is estimated to be around US $ 4.60 trillion. As per the available trade statistics by the International Trade Centre (ITC), the value of global spice import has gone up from US $1.60 billion in 1996 to US $ 2.97 billion in 2004. Spices have various uses in medicinal, aromatic, flavouring and social customs. They add pungency and flavour to the Indian cuisine. Seed spices are used as condiment in Indian cooking and as flavouring agents. The spices are also used in all auspicious social functions in India.

Though India produces nearly 0.4 million tonne of spices per annum, the export is only 37,000 tonnes, which is less than 10 per cent. This is mainly due to non-availability of exportable surplus that should comply with the high standards and quality expected by the buying country. As the spice crops have restricted

geographical distribution, the possibility of area expansion is very much limited and the increasing demandin production of spices can be met only by increasing the productivity through improved varieties and modernising input technologies.

1.2. Turmeric - economically **important spice**

India is the world's largest producer of turmeric *(Curcuma longa* Linn.) known as 'Indian Saffron' and considered the best due to its high curcumin content. It is used in diversified industries as condiment, as flavouring and colouring agent and principal ingredient in curry powder apart from pharmaceuticals and cosmetic industry. The country consumes 80 per cent of turmeric production and the rest is exported. Turmeric is grown in as many as 25 states of India with Andhra pradesh, Tamil Nadu, Karnataka, and Orissa being the leading producers. Other main producers of turmeric are Gujarat, West Bengal, Assam, Meghalaya, and Maharashtra. India has nearly 1,73,000 ha under turmeric cultivation with a total production of 0.855 million tonnes during the year 2008. Andhra Pradesh topped both in area and production during the year 2005-06 with 69,990 ha (40.46 per cent) and 5,18,550 tonnes (60.60 per cent) respectively. Tamil Nadu followed with acreage of 25,970 ha (15.01 per cent) and production of 1,43,358 tonnes (16.75 per cent). The year wise production of turmeric in India is given in Table 1.1 and the state wise production of turmeric is given in Table 1.2.

Table 1.1. Indian production of turmeric

Year	Area (ha)	Production (MT)
1997-98	139,700	549,200
1998-99	160,700	597,900
1999-00	161,300	653,600
2000-01	187,431	719,609
2001-02	162,950	552,300
2002-03	149,710	525,740
2003-04	150,730	565,470
2004-05	158,060	715,360
2005-06	173,005	855,763

(Source: Spice Board of India, Feb 2008)

Table 1.2. State wise production of turmeric

State	Area		Production	
	Area (ha)	% Share	Production (MT)	% Share
Andhra Pradesh	69,990	40.46	518,550	60.60
Tamil Nadu	25,970	15.01	143,358	16.75
Orissa	24,020	13.88	57,090	6.67
West Bengal	11,844	6.85	25,049	2.93
Gujarat	1,400	0.81	16,510	1.93
Karnataka	5,410	3.13	26,380	3.08
Assam	6,760	3.91	8,427	0.98
Other states	27,611	15.95	60,399	7.06
Total	173,005	100.00	855,763	100.00

(Source: Spice Board of India, Feb 2008)

The total national output of turmeric which was 549,200 tonnes from 139,700 ha in 1997-98 has gone up to 855,763 tonnes from around 173,005 ha in 2005-06. India accounts for about 80 per cent of world's turmeric production and 60 per cent of world's exports. The details of export of turmeric are given in Table 1.3.

Table 1.3. Indian exports of turmeric

Year	Quantity (MT)	Value **(Rs. million)**
1996-97	23,019	584.4
1997-98	28,875	830.6
1998-99	37,297	1291.4
1999-00	37,776	1235.1
2000-01	44,627	1155.7
2001-02	37,778	907.3
2002-03	32,402	1033.7
2003-04	37,044	1311.1
2004-05	43,09*7	1562.5
2005-06	46,405	1528.6
2006-07	51,500	1648.0

(Source: Spice Board of India, Feb 2008)

Some of the important turmeric varieties exported from India are: Allepey finger turmeric, Rajapuri, Madras, and Erode varieties. The processed forms of turmeric exported are dry turmeric, fresh turmeric, turmeric powder, and oleoresin. United Arab Emirates is the major importer, accounting for 18.35 per cent of the total exports followed by the USA with 11.44 per cent. The other leading importers are Japan, UK, and Sri Lanka. The quality stipulation followed by the USA is considered to be more important for export of turmeric. The country wise export of turmeric from India is given in Table 1.4.

Table **1.4. Important importing countries** of **turmeric from** India

Country	**Quantity (MT)**	**Value** (Rs. **million)**	**% Share**
UAE	5,020.75	151.162	18.35
USA	3,128.99	103.931	11.44
Bangladesh	2,807.01	61.441	10.26
Japan	2,373.99	110.427	8.68
Sri Lanka	1,611.02	35.101	5.89
Malaysia	1,555.86	68.012	5.68
UK	1,491.42	63.468	5.45
South Africa	984.03	41.394	3.59
Netherlands	900.05	36.062	3.29
Saudi Arabia	735.02	23.506	2.68
Morocco	597.24	17.955	2.18
Egypt (ARE)	543.64	23.306	1.98
Others	5,610.00	223.043	20.51
Total	27,359.13	958,808	100.00

(Source: Spice Board of India, Feb 2008)

1.3. Need for increasing productivity of turmeric through mechanisation

The Spices Board reported a decline in the area under turmeric in 2008-09 which would create a short fall in production against increasing demand (Spices Board of India, Feb. 2008). This clearly necessitates the need for adopting modem input technologies including mechanisation to improve productivity by way of reducing the losses. A suitable mechanical harvesting technology for turmeric is required not only to reduce field losses and to obtain higher productivity but also to reduce the drudgery of human labour required for manual harvesting of turmeric rhizomes.

1.4. Benefits of mechanised crop production

Mechanisation helps in achieving the required tilth of soil in less time in land preparation, perfect formation of ridges for planting, timely planting of seed material, timely weeding operations, proper application of crop protection measures, timely harvesting, achieving higher efficiency of harvesting with less cost and obtaining many other tangible and intangible benefits. One important way of improving productivity is to reduce the field losses and damages to the produce at the time of harvest and thus increase the actual yield that has been realised.

1.5. Tractorisation in farming

The level of farm mechanisation is virtually confined to tractorisation only. Tractor use is gradually increasing for land preparation and haulage work. Partial mechanisation of turmeric farming in the country will introduce cost efficiency and timeliness. It will pave the way for the young entrepreneurs to come up with their own enterprise or custom service centers. There is no doubt that partial mechanisation will usher a new era. If taken up in the right perspective, it will not only solve the numerous problems of the country in general and farmers in particular, but will also dispel the apprehension that mechanisation will lead to the displacement of human labour force, rather more employment avenues will be opened. Man and machine will work not as competitor but as a compliment to each other.

India has emerged as the world's largest manufacturer of four-wheel farm tractors with its annual sale crossing 296,080 during 2005-06. India has now a population of over 2.0 million tractors operating in the farms and the farmers invest more than Rs. 200,000 million annually in the form of agricultural engineering inputs. These farm tractors are fast replacing the pair of bullocks for the tillage and other farming operations. Today the sale of tractors in the country is increasing steadily and the use of tractor increased at a compound growth rate of more than 13 per cent annually which may stabilize around 10 per cent by next decade. It is obvious that tractors are more popular and it has become the major source of farm power. The agricultural engineering programmes in the countiy should aim to ensure their sustainability and hence the system should cover areas such as a complete range of matching implements.

1.6. Conventional method of turmeric harvesting

The turmeric rhizome is conventionally harvested from the soil with a fork type spade. The operation is highly labour intensive requiring only skilled labour. Since the rhizomes spread down 15 to 20 cm deep in the soil, it will not be possible to achieve digging of the entire rhizome by manual digging and hence considerable quantity of rhizome is left undug. The damage caused to the rhizome by the fork type spade is also considerable.

1.7. Mechanical method of turmeric harvesting

The need to improve the yield realised by reducing field losses in turmeric emphasises the importance to develop suitable mechanical harvesting technology for turmeric. Moreover, the increasing non-availability of skilled labour for this work and the prevailing higher harvesting charges demanded make it all the more essential, the need to develop mechanical means of harvesting turmeric. Keeping this in mind, attempts were made to develop machine for the mechanical harvesting of turmeric.

A few power tiller operated turmeric harvesters have been developed by Tamil Nadu Agricultural University (TNAU), India and other agencies. But the power requirement for deeper digging up to 200 mm depth to uproot the turmeric rhizomes without damage is higher and the power tillers are not able to deliver the required power. A tractor operated turmeric harvester would be able to dig out the rhizomes deeper. Earlier, the researchers developed a tractor mounted turmeric digger with two digger blades each of size 825x150x10 mm joined together for proper penetration and to reduce draft. The tubers were left in soil without inversion. Another model of tractor mounted turmeric digger with single blade was developed at TNAU in 1999. These diggers dig out and partially lift the rhizomes leaving them behind the tractor. The rhizomes have to be collected manually by human labour. The draft requirement is 330 kgr for the tractor mounted digger of 1200 mm blade length and the field capacity was 2 ha/day.

The Farm Implement and Machinery (FIM) Centre at Mahatma Phule Krishi Vishwavidhyalaya (MPKV), Rahuri, India has also developed a tractor mounted turmeric digger during 2002 having the blade length of 600 mm with 180-200 mm depth of digging. A set of lifting rods / gathering rods at the rear of the blade lifts the harvested rhizome to drop it backward.

All the above models of turmeric harvester had only blades and tools for digging, leaving the rhizomes in the dug soil. Separate manpower has to be employed to collect the harvested rhizome, which requires about 90-100 woman-days/ha. Studies revealed that the cost of collecting the harvested produce covered about 85 per cent of the labour cost in machine harvesting and 70 per cent of the labour cost in manual harvesting.

1.8. Need for turmeric harvester

With tractor already available in the farms, development of suitable attachment to harvest the turmeric rhizome appear to be the most appropriate mechanical harvesting technology to satisfy the requirements in harvesting turmeric namely, to achieve maximum yield realisation with minimum field losses, minimum damage and at lesser cost.

An appropriate digging tool, namely, a digging blade and a soil separation and rhizome collection mechanism, would make the harvester complete in all respects. If a suitable mechanism could be developed for removing the soil coming with rhizome and collecting the rhizome, it could be more efficient and beneficial to farmers. With these in view, the investigation envisaged to develop a suitable tractor mounted turmeric harvester to dig out and collect the turmeric rhizomes.

1.9. Objectives

The present investigation entitled **'Investigations on machine parameters in the development of tractor mounted harvester for turmeric'** was taken up with the following objectives.

1. Study of existing harvesting practices for turmeric.
2. Investigations and optimization of various machine parameters for mechanical harvesting.
3. Development of prototype tractor mounted turmeric harvester.
4. Evaluation of the prototype harvester in farmers' field.
5. Cost economic analysis of the harvester in comparison with manual harvesting.