Chapter 9
Crop Loss Assessment in India- Past Experiences and Future Strategies

T. V. K. Singh, J. Satyanarayana and Rajinder Peshin

Contents

Abstract India is basically an agrarian country. The Green Revolution in India led to a quantum jump in agricultural production thereby allowing domestic food availability to comfortably meet domestic food demand. In the Indian sub-continent, insect pest problems in agriculture have shown a considerable shift from the Green Revolution era to the first decade of the twenty-first century due to agro-ecosystem and technological changes. Global losses due to insect pests have declined from 13.6 % in post-Green Revolution era to 10.8 % towards the beginning of this century. In India, the crop losses have declined from 23.3 % in post-Green Revolution

T. V. K. Singh (✉) · J. Satyanarayana
Department of Entomology, Acharya N. G. Ranga Agricultural University,
Rajendranagr, Hyderabad 500 030, India
e-mail: tvksingh@yahoo.com

J. Satyanarayana
e-mail: snjella@gmail.com

R. Peshin
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus,
Chatha, Jammu 180009, India
e-mail: rpeshin@rediffmail.com

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era to 17.5% at present. In terms of monetary value, Indian agriculture suffers an annual loss of about US$ 42.66 millions due to insect pests. With the intensive cultivation, commiserative improvement and intensification measures to protect the crops have to be taken. During the last decade, visible progress has been made in the development of biological control strategies, insect resistant crops plants and genetically engineered crops. All these measures if suitably employed in integrated pest management (IPM) along with improvement in crop protection services should lead to a substantial reduction in crop losses due to pests.

Keywords India · Crop losses · Insect pests · Monetary losses

9.1 Introduction

Food plants of the world are damaged by more than 10,000 species of insects, 30,000 species of weeds, diseases (caused by fungi, viruses, bacteria and other microorganisms) and 1,000 species of nematodes (Dhaliwal et al. 2007). However, less than 10% of the total identified pest species are generally considered as major pests. The severity of pest problems has been changing with the developments in agricultural technology and modifications of farming practices.

India is basically an agricultural country and has highly variable climatic regions owing to its geographic features. Total arable land area is 168 million ha and a major part of it falls under tropical climate, and allows for the cultivation of a variety of cereals, oil seeds, pulses, vegetable and horticultural crops. India has achieved self-sufficiency in food grains but there is an urgent need to improve the productivity in all crops to meet future challenges. India needs to produce an additional 5–6 million tons of food grains every year to keep pace with the growth of our population (Paroda 1999). To realize this goal, one of the important stumbling blocks seems to be the yield losses due to insect pests. There is an urgent need to assess such losses, and frame strategies to reduce it.

To assess the yield losses in many crops, studies have to be carried out systematically, but still the losses caused by individual pests are not distinguished from the whole pest complex. Yield loss estimates vary depending on type of the cultivar, density of pest population, time of pest attack in relation to crop phenology and cultural practices followed. Another problem is that most of the studies are conducted in small experimental plots in research stations rather than in farmers' fields, which may not give an exact picture of the losses caused by insects (Table 9.1).

Extensive surveys carried out by various agencies in India during the 1950s revealed that fruits, cotton, rice and sugarcane suffered 25, 18, 10 and 10% yield losses, respectively, due to ravages of insect pests (Pradhan 1964) (Table 9.1)

The introduction of high yielding varieties (HYVs) along with application of agrochemicals including fertilizers increased the productivity of cropland with a concomitant increase in the proportion of crop yield lost to insect pests. Unfortunately, very little information is available regarding the extent of losses due to insect

Table 9.1 Losses in field crops due to insect pests in traditional agriculture. (Source: Pradhan 1964)

Crop	Loss in yield (%)
Rice	10
Wheat	3
Maize	5
Sorghum & millets	5
Cotton	18
Sugarcane	10
Fruits	25

Table 9.2 Worldwide crop losses (%) due to insect and mite pests during pre- and post-Green Revolution era. (Source: Benedict 2003)

Crop	Pre-Green Revolution (1965) (A)	Post-Green Revolution (1988–90) (B)	Changes in loss (B-A)
Barley	3.9	8.8	+4.9
Cotton	16.0	15.4	−0.6
Maize	13.0	14.5	+1.5
Potatoes	5.9	16.1	+10.2
Rice	27.5	20.7	−6.8
Soybean	4.4	10.4	+6.0
Wheat	5.1	9.3	+4.2
Average	10.8	13.6	+2.8

pests in different crops in India and other developing Asian countries (Dhaliwal and Arora 1994). However, even the limited available information reveals that crop losses due to pests are higher for India than for other parts of the world (APO 1993).

The overall losses due to insect pests were estimated to be US$ 2.9 million in 1983 (Krishnamurthy Rao and Murthy 1983), US$ 2.9 million in 1986 (Atwal 1986), US$ 9.80 million in 1993 (Jayaraj 1993) and US$ 14.4 million in 1996 (Dhaliwal and Arora 1996). Raheja and Tewari (1997) had indicated that losses due to *H. armigera* alone may be US$ 18,225,000 annually. Studies have revealed that the losses caused by key insect pests varied from 10 to 50%. Apart from inflicting direct losses, insect pests also act as vectors for transmission of several viral diseases, of which aphids alone transmit about 160 viruses and leafhoppers about 35 viruses (Puri 2000).

Crop protection aims to avoid or prevent crop losses or to reduce them to economically acceptable losses; the availability of quantitative data on the effect of different categories of pests is very limited. The first attempt to estimate crop losses due to various pests on a global scale was made by Cramer (1967). Subsequently, Oerke et al. (1994) carried out an extensive study to estimate losses in principal food and cash crops. In spite of the widespread use of synthetic pesticides and other control measures, the losses due to insect and mite pests increased in the post-Green Revolution era (Oerke et al. 1994) over the pre-Green Revolution era (Cramer 1967). Worldwide total pre-harvest losses for post-Green Revolution era (1988 through 1990) period was estimated to value at US$ 801,900,000 for eight principal food and cash crops (barley, coffee, cotton, maize, potato, rice, soybean and wheat) (Benedict 2003) (Table 9.2).

Table 9.3 Crop losses (%) due to insect pests during pre- and post-Green Revolution in India.

Crop	Pre-Green Revolution (early 1960s)	Post-Green Revolution (early 2000s)
Cotton	18.0	50.0
Groundnut	5.0	15.0
Other oilseeds	5.0	25.0
Pulses	5.0	15.0
Rice	10.0	25.0
Maize	5.0	25.0
Sorghum and millets	3.5	30.0
Wheat	3.0	5.0
Sugarcane	10.0	20.0
Average	7.2	23.3

Losses due to insect pests in Indian agriculture have been estimated from time to time (Pradhan 1964; Krishnamurthy and Murthy 1983; Atwal 1986, Jayaraj 1993; Lal 1997; Dhaliwal and Arora 1996; 2002; Dhaliwal et al. 2003, 2004). The actual losses due to various pests have been estimated as 26–29 % for soybean, wheat and cotton, and 31, 37 and 40 % for maize, rice and potatoes, respectively. In general, the losses in the post-Green Revolution era (Dhaliwal et al. 2004) have been increasing compared to losses during the pre-Green Revolution era (Pradhan 1964). Overall, the losses increased from 7.2 % in the early 1960s to 23.3 % in the early 2000s (Table 9.3). The maximum increase in loss occurred in cotton (18.0–50.0 %), followed by other crops like sorghum and millets (3.5–30.0 %), maize (5.0 to 25.0 %) and oilseeds (other than groundnut) (5.0–25.0 %).

There has been a paradigm shift in crop management in Indian agriculture since the beginning of this century. *Bacillus thuringiensis* (Bt) cotton was released in the country in 2002 and the area under Bt cotton increased from 50,000 ha in 2002 to 8.4 million ha in 2009. Of the estimated 9.6 million ha of cotton in India, 87 % was under Bt cotton in 2009 (James 2009). Second, concerted efforts were made to implement integrated pest management programs in principal food and cash crops. As a result of these developments, losses due to insect pests in several agricultural crops are declining. However, in terms of monetary value, the decline in losses does not appear to be significant due to both the increase in production levels and the increase in prices of different commodities.

9.2 Losses in Various Crops

9.2.1 Rice

Rice, *Oryza sativa* (L.), is the staple food in India for 65 % of the population. Rice is the most important source for meeting the caloric and dietary protein needs of the people as well as for generating employment and income, particularly for low income groups in rural areas. The crop accounts for about 22 % (44.6 million ha) of the total cropped area with an output of 87 million t, which forms approximately 46% of the cereals production and 42% of the total food grains.

More than hundred species of insects have been recorded as pests of rice, of which about a dozen are of economic significance in India (Gururaj Katti et al. 2010).

Assessment of losses through analysis of 135 multi-location trials under the All India Coordinated Rice Improvement Project (AICRIP) revealed that the avoidable losses due to insect pests averaged 28.8% in rice. Worldwide, Oerke et al. (1994) reported losses of 51.4% of the attainable yields in rice of which 20.7% was due to animal pests including insect pests, 15.6% due to weeds and 15.1% due to pathogens. The equivalent monetary loss in yield for rice amounted to $ 113 billion.

The estimated loss from stem borer damage varies from 3 to 95%. The relation between injury and yield is considered to be generally non-linear and plants exhibited a high degree of tolerance to initial injury. Plants with as high as 30% dead hearts from stem borer attack may have no significant yield losses and as much as 10% white earheads can be tolerated (Teng et al. 1993). A higher degree of tolerance has been recorded under higher doses of fertilizer applications. Insect damage is thus speculated to depend on the crop age and nutritional status when the crop was infected, in addition to factors such as insect densities and feeding duration.

Brown plant hopper, *Nilaparvata lugens* Stal, causes 10–70% losses, whereas related species, white backed plant hopper, *Sogatella furcifera* Horvath causes 10–80% loss. Gall midge, *Orseolia oryzae* (Wood-Mason), an endemic pest in certain parts of the sub-continent is known to cause 15–60% loss (Puri et al. 1999)

Leaf folder, *Cnaphalocrocis medinalis* (Guen.), once considered a minor pest, has now attained a major pest status with the spread of high-yielding rice varieties, continuous availability of rice crop in double cropping areas and the accompanying changes in cultural practices like increased application of fertilizers and use of broad-spectrum insecticides. Rice yield losses due to leaf folders range from 63–80%, with high-yielding or hybrid rice varieties being more susceptible (Teng et al. 1993). Shanmugam et al. (2006) identified leaf folder as one of the most serious productivity constraints responsible for yield gap of rice in Tamil Nadu, India, accounting for an 11.18% loss. However, the field larval stage and density as well as stage of the crop are the major factors that determine the quantum of larval feeding and yield reduction (Heong 1990).

The overall field losses due to insect damage in rice were estimated at 35–44% (Pathak and Dhaliwal 1981). The average yield loss due to insect pests was estimated to vary from 21 to 51% (Singh and Dhaliwal 1994). Damage during vegetative phase (50%) contributed more to yield reduction than during the reproductive (30%) or ripening phase (20%) (Litsinger et al. 1987).

9.2.2 Wheat

Wheat, *Triticum aestivum* L., is a major rabi (spring harvest) cereal crop and insect pests are usually not a limiting factor in wheat production. The annual monetary loss of US$ 75.3 million has been reported due to insect pests in wheat in India

(Dhaliwal and Koul 2010). It has been further reported that the losses due to insect pests in wheat have increased from 3 to 5% after the Green Revolution. This could be ascribed to change in the pest scenario in wheat. Till late 1960s, barring Gujhia weevil, *Tanymecus indicus* Faust and grasshopper there were hardly any serious pests of wheat, but with the introduction of high yielding semi-dwarf varieties, changed cropping systems, and use of new agro techniques, some new insects attained pest status. The termites, aphids, armyworm, American pod borer and brown mite are now major pests of wheat (Deol 2002). Severe losses may result from termites (up to 91.4%), shoot fly (30.7%), armyworms (42.2%), aphids (36.4%) and mites (15%) under favorable environmental conditions (Deol 1990).

9.2.3 Sorghum

Sorghum, *Sorghum bicolor* (L.) Moench is an important cereal crop in Asia, Africa, North and South America and Australia. Grain yield for farmers' fields in the semi-arid tropics are generally low (500–800 kg ha^{-1}) mainly due to insect pest damage. Nearly 150 insect species have been reported as pests on sorghum, of which shoot fly, stem borer, shoot bug, midge, ear head bug and head caterpillars are the major pests.

Shoot fly, *Atherigona soccata* (Rondani), and stem borer, *Chilo zonellus* Swinhoe, are reported causing 2,534 and 860 kg ha^{-1} loss in grain and 2,511 and 4,100 kg ha^{-1} loss in fodder yield of the crop grown during rabi (winter) and *kharif* (rainy season), respectively. Shoot bug, *Peregrinus madis* (Ashmead), which was previously a minor pest, has now assumed major status in certain parts of the states of Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu. In India, it is reported to cause crop loss up to 41% (Manisegaran and Soundarajan 2008).

The National Council of Applied Economic Research, on the basis of multi-location trials over several years before the advent of high yielding varieties, estimated a yield loss of 12.1% due to insect pest damage to sorghum crop (NCAER 1967). Total avoidable and real losses due to the insect pest complex in sorghum hybrid CSH-5 were estimated to be 32.2 and 53%, respectively. During recent years, yield losses varying from 55 to 100% have been recorded in northern India due to stem borer damage in sorghum. Shoot fly has been estimated to cause 22–80% loss to crop in Maharashtra.

9.2.4 Maize

Maize, *Zea mays* (L.), originated in Central America and is now a principal cereal crop in the tropics and subtropics. Stem borer, *Chilo partellus* Swinhoe is a limiting factor in the successful cultivation of this crop, and is reported to cause 24–83% crop loss in India. The losses due to *C. partellus* ranged from 27.6 to 80.4% and the combined avoidable losses in maize yield due to stem borer and shoot fly has been estimated to be 20–87% and the shoot fly, *Atherigona* spp, alone is known to cause damage ranging from 69 to 97% (Mathur 1992) and up to a 20% grain yield loss (Pathak et al. 1971).

Pink stem borer, *Sesamia inferens* Walker, causes serious damage to maize in the winter season particularly in peninsular India where the average yield loss in maize may vary from 25.7 to 78.9% (Sarup et al. 1971).

9.2.5 Pulses

Various pulse crops are attacked by around 250 insect species. Pigeon pea, *Cajanus cajan* (L.), is one of the major pulse crops grown in India. It covers about 16.5% of the total area under pulses in India and contributes about 18.5% towards the total pulse production in the country.

In a survey conducted by International Crop Research Institute for Semi-Arid Tropics (ICRISAT), *Melanagromyza obtusa* Malloch was reported to damage 22.5% pigeon pea pods in North India, 21% of pods in Central India and 13.2% of pods in South India, whereas the pod borer damage was reported to be 29.7% in North-West region of India, 13.2% in North India, 24.3% in Central India and 36.4% in South India. The annual loss of pigeon pea production due to pod fly alone has been estimated at 25–30%. The total grain loss due to pod sucking bugs damage has been worked out to be 50,000 t. In case of pigeon pea, pod borer, *Helicoverpa armigera* (Hub), has been reported to cause yield losses varying from 40 to 50% in major pigeon pea growing states.

In case of pulses, pod borer, *H. armigera*, has been reported to cause yield losses varying from 4.2 to 39.7% in 12 major chickpea growing states. The average loss due to insect pest damage in chickpea has been estimated at 29.2% at the national level. In case of pigeon pea, losses often exceed 50%, while in blackgram, avoidable losses were estimated at 34.7 and 28.7% in Bihar and Andhra Pradesh, respectively (Krishnamurthy Rao and Murthy 1983; Rao et al. 1990). In Haryana, *H. armigera* was found to damage 13.7% pods and 5.3% of the grain of pigeon pea, whereas *M. obtusa* damaged 9.4–10.1% pods and 3.1–3.5% of the grain (Yadav and Choudhary 1993). On an average, a single larva per plant of pigeon pea reduces the yield by 138.5 kg/ha of the expected yield (Reddy et al. 2001). On average 30–80% crop losses occur in pulses due to ravages of insect pests valued at US$ 72,900,000 (Asthana et al. 1997). The average loss due to the insect pests in urdbean, *Vigna radiate* (L.), and mung bean, *Vigna mungo* (L.), was estimated to be 34.7 and 28.7% in different states of India, respectively.

9.2.6 Commercial Crops

9.2.6.1 Cotton

The losses due to animal pests in cotton, *Gossypium hirsutum* L., have been estimated at 30% in India and 20% in Pakistan (Table 9.4). Bollworms and sucking pests have been causing various degrees of loss in different states of India (Table 9.5). The National Council of Applied Economic Research, on the basis of experiments

Table 9.4 Actual and potential crop losses in cotton due to various pests in Asia. (Source: Oerke et al. 1994)

Region	Crop losses (%) due to					
	Animal pests		Diseases		Weeds	
	Actual	Potential	Actual	Potential	Actual	Potential
Near east south Asia	17	55–60	10	15–20	12	50–55
India, Myanmar, Sri Lanka	30	55–60	15	15–20	25	55–60
Bangladesh, Pakistan	20	55–60	12	15–20	15	55–60
Southeast Asia	22	55–60	12	15–20	IS	57–62
East Asia	15	55–60	10	15–20	10	55–60

Table 9.5 Potential crop losses in cotton due to insect pests in various states of India. (Source: Oerke et al. 1994)

State	Pests	Potential loss %
Punjab	*Bemisiatabaci* (Gennadius)	8.31
	Bollworms, jassids, *B. tabaci*	63
	Bollworms and jassids	52
	Bollworms (on G. *arboreum)*	37
	Bollworms (on G. *hirsutum)*	51
	Bollworms	18–66
Delhi	Bollworms	79
	Bollworms	25–75
	Bollworms	48
	All	52
Haryana	Bollworms	39
Gujarat	Bollworms	69
	Jassids, bollworms	39–44
	Jassids, bollworms	67–81
Andhra Pradesh	*B. tabaci*	11–49
Maharashtra	Bollworms	63
	Bollworms	59
	Bollworms	46
	Bollworms	51
	Aphids	5
Tamil Nadu	Jassids, bollworms, aphid	At least 55
	Jassids, thrips, aphids	81–82

undertaken in seven states between 1950–1951 and 1965–1966, estimated an average loss of 40.3 % in seed cotton yield due to insect pests. In Maharashtra, still higher losses of 16.3, 71.7 and 94.2 % were attributed to sucking pests, bollworms and all insect pests, respectively (Taley et al. 1988). The Central Institute of Cotton Research (CICR), Nagpur, attributed an average loss of 50–60 % in seed cotton yield to infestation by insect pests. *H. armigera* and whitefly, *Bemisia tabaci* (Gennadius), attained the status of most severe pests, especially in northern India. Before the introduction of Bt cotton hybridization in India, Satpute et al. (1988) reported that minimum losses in cotton were caused by sucking pests (4.6 %) while maximum losses were caused by bollworm in cotton (51.3 %).

9.2.6.2 Sun Hemp

The fiber loss in sun hemp, *Crotalaria juncea* L., due to top shoot borer, *Cydia* (*Laspeyresia) tricentrata* Meyr, has been estimated to be 16.67–20.63 % (Prakash 1990).

9.2.6.3 Sugarcane

In sugarcane, *Saccharum officinale* (Sacch.), insect pests cause enormous losses both in tonnage and recovery of sugar in mills. Losses due to different insect pests vary greatly for different locales. However, by conservative estimate, growers lose about 20 % in sugarcane yield and sugar factories suffer a loss of about 15 % sugar recovery due to the ravages by insect pests (Avasthy 1983).

9.2.7 Oilseed Crops

The 'Yellow Revolution' in India during the early 1990s made the country self-sufficient in oilseeds production, but this self-sufficiency lasted only for a short period. At present the demand for edible oils has outstripped the supply. About 40 % of the country's edible oil requirements is met by imports. Oil seeds crops are mainly grown under energy deprived conditions with low inputs. According to one estimate, insect pests are known to cause 15–30 % loss in yield in different oilseed crops (Dhaliwal et al. 2004), thus devouring up to one third of the agricultural produce.

9.2.7.1 Groundnut

Among the various pests infesting groundnut, *Arachis hypogaea* L., white grubs, leaf miners and sucking pests have been reported to cause heavy damage. The losses due to insect pests varied from 5 to 10 % in Maharashtra to 4 to 70 % in Gujarat. At the national level losses due to the insect pest complex in groundnut have been estimated at 48 % (Krishnamurthy Rao and Murthy 1983). The loss in yield due to leafhopper and thrips in groundnut has been estimated to be 48.5 % in Tamil Nadu (Shivalingaswamy and Palanisamy 1986). Pod yield losses of 49–56 % due to the leaf miner, *Aproaerema modicella* Deventer, have been reported (Wightman and Amin 1988).

9.2.7.2 Mustard

A number of insect pests are known to attack rapeseed-mustard, *Brassica* spp. in India. Of these, the mustard aphid, *Lipaphis erysimi* Kalt, is the key pest and causes colossal yield losses year after year. Continuous feeding by large aphid colonies debilitate plants by sucking sap, Debilitated plants produce less seeds. Due to high fecundity, short generation time and prolific breeding the mustard aphid is a major constraint in the successful cultivation of rapeseed-mustard. Yield losses estimated due to mustard aphid varied from 4 to 81 % during different years at various locales in the country. The losses also varied among different Brassica species. Higher losses were reported in *B. campestris* and *B. mapus*, lower in *B. carinola* and highly variable in *B. juncea* (Arora 1999).

In India, the yield losses due to mustard aphid was estimated to be 35–73 % and in addition, there was a 6–10 % reduction in oil content, seed size and seed viability in unprotected crop (Arora 1999). In addition to aphid, mustard sawfly, *Athalia lugens* Klug, and leaf miner, *Chromatomyia horticola* Goureau, have also been reported to cause yield losses of 5–18 % and 15.2 %, respectively (Arora 1999).

9.2.7.3 Sesamum and Niger

The avoidable yield losses due to insect pests were estimated to be 18.4, 24.0 and 25.7 % in multi-location trials under the All India Coordinated Research Project on Oilseeds (AICORPO) in sesamum, *Sesamum indicum* L., sunflower and linseed, respectively. Saxena and Jakhmola (1993) reported 10–60 % loss in yield due to shoot webber and pod borer, *Antigastra catalaunalis* (Dup.), in sesame. The seed damage in infested pods due to *Penthicoides seriatoporus* and *Anisolabis annulipes* (Lucas) in groundnut, *A. catalaunalis* in sesame and *Conogethes punctiferalis* (Guenee) in castor was 63.5, 73.4 and 42.3 %, respectively and the corresponding weight loss of damaged seeds was 59.2, 100.0 and 63.0 % (Kapadia 1996). Gupta et al. (2000) reported that avoidable losses due to *A. catalaunalis* varied from 6.2 to 43.1 % in different genotypes of sesamum. The mean yield loss due to insect pests in Niger was estimated to be 36.2 % at Hyderabad (Basappa 2000).

9.2.7.4 Sunflower

Crop losses due to insect pests in sunflower *Helianthus annuus* L. vary from region to region. Defoliators attack before flower initiation, affecting the source partitioning between stem, leaves and roots and in the later stages affecting the growth of both the vegetative parts and inflorescence. The plant stand of sunflower crop can be reduced by more than 30 % (Basappa and Bhat 1998).

Leaf hoppers alone have reportedly caused crop loss ranging from 18.5 to 46.3 % in Maharashtra (AICRP 1979). Capitulum borer, *Helicoverpa armigera* (Hub), is the key pest that has worldwide distribution and has been observed in most of the agro-ecological regions of India. Capitulum borer alone causes up to 50 % yield loss by directly inflicting damage to flower buds, ovaries and developing seeds. Crop loss due to capitulum borer is more if the star bud and bloom stage of the crop coincides with peak activity of the pest. The loss in seed yield due to defoliators in a rain fed kharif crop was up to 268 kg/ha at Bangalore. Panchabhavi and Krishnamurthy (1978) reported yield loss of 120 kg/ha due to *H. armigera* damage in Karnataka.

9.2.7.5 Castor

The defoliation of castor *Ricinus communis* L. by semilooper, *Achaea janata* Linn. and *Spodoptera* is common on the Deccan plateau; defoliators are quite unimportant in Gujarat except in isolated locations in some years. Heavy infestations of semilooper often result in the abandonment the affected fields. *Spodoptera* and hairy caterpillars lay eggs in groups and the gregarious larvae feed on the same leaf for 3–4 days before dispersing to other plants.

The capsule borer which was a minor pest in the past has become more serious in recent years causing 20–50 % capsule damage in southern India. The damage is high when the larvae bore at the base of the young spike, which results in the withering and death of the whole spike.

9.2.8 Vegetables

Crop loss in vegetables is more important because even a little deterioration in quality of the produce results in complete loss in marketability. Thus, besides the quantitative loss, qualitative loss is more magnified in case of vegetable products.

In vegetables, the pest status in a particular crop varies from place to place depending on different agroclimatic zones of India. The yield loss caused by these pests not only depends on the prevalence of the pest but also the type of cultivars in vogue in a given region. The biotic factors are regulated by climate and these biotic factors ultimately influence the pests. The yield loss caused by important insect pests of vegetables is given in Table 9.6.

9.3 Current Status

From the available data, an effort has been made to quantify the monetary loss for all the major crops based on the latest figures for national production and minimum support prices for these crops. Rice alone suffers a loss of US $ 2679.95 million closely followed by cotton with US $ 2230.59 million annually due to insect pest damage. All other major crops including sugarcane, maize, other coarse cereals, pulses, rapeseed-mustard, groundnut, other oilseeds and wheat suffer losses well in excess of US $ 161 million each. The monetary value of annual yield losses in all important agricultural crops,based on 2000-2001 minimum support prices fixed by the Ministry of Agriculture, Government of India, is estimated to be US $ 7214.2 million (Dhaliwal and Arora 2002).

Table 9.6 Yield loss due to insect pests in vegetables (by state)

Crop/Pest	Yield loss (%)	State	Source
Cabbage			
Diamond back moth, *Plutella xylostella* (L.)	9.8–16.8	Karnataka	Viraktamath et al. 1994
Cabbage whitefly, *Peiris brassicae* (L.)	68.5	Meghalaya	Thakur 1996
Cabbage caterpillar, *Crocidolomia binotalis* Zeller	28.9–50.8	Karnataka	Peter et al. 1988
Cabbage borer, *Hellula undalis* Fab	30–58	Karnataka	Shivalingaswamy et al. 2002
Chinese cabbage sawfly, *Athalia proxima* Klug	36.5	Uttar Pradesh	Ram et al. 1987
Aphid, *Lipaphis erysimi* Kalt	36.5	Uttar Pradesh	Ram et al. 1987
	44–54	Karnataka	Shivalingaswamy et al. 2002
Chillies			
Thrips, *Scirtothrips dorsalis* Hood	11.8	Assam	Borah and Langthasa 1995
	50	Tamil Nadu	Nelson and Natarajan 1994
	>90	Karnataka	Kumar 1995
Egg plant			
Fruit and shoot borer, *Leucinodes orbonalis* Guenée	50	Tamil Nadu	Srinivasan and Gowder 1969
	48	Maharashtra	Mote 1981
	11.1–47.18	Punjab	Shivalingaswamy et al. 2002
	54–66	Karnataka	Krishnaiah 1980
	25.82–92.50	Rajasthan	Kumar and Shukla 2002
	20.54	Uttar Pradesh	Mall et al. 1992
Tomato			
Fruit borer, *Helicoverpa armigera* (Hub.)	22.9–37.7	Karnataka	Tewari and Moorthy 1984
Okra			
Jassids, *Amrasca biguttula biguttula* Ishida	54–66	Karnataka	Krishnaiah 1980
Whitefly, *Bemisia tabaci* (Gennadius)	54.04	Rajasthan	Shivalingaswamy et al. 2002
Shoot and fruit borer, *Earias vittella* (Fab.)	54.04	Rajasthan	Shivalingaswamy et al. 2002
	38.43	Uttar Pradesh	Satpathy and Rai 1998
	22.9–50.5	Punjab	Brar et al.1994
Cucurbits (only fruit fly damage) Fruit fly, *Bactrocera cucurbitae* (Coquillett)			
Cucumber	20–39	Assam	Borah 1996
	80	Himachal Pradesh	Gupta and Verma 1992
Little gourd	63	Gujarat	Patel 1994
Muskmelon	76–100	Rajasthan	Pareek and Kavadia 1994
Snake gourd	63	Assam	Borah and Dutta 1997
Sponge gourd	50	Andhra Pradesh	Gupta and Verma 1992
Potato			
Potato tuber moth, *Phthorimaea operculella* Zeller	14.4–55.4	Karnataka	Trivedi et al. 1994
Agrotisi psilon Hufnagel	2.78–7.39	Himachal Pradesh	Misra and Sharma 1988
Holotrichia sp.	98.3	Himachal Pradesh	Misra and Sharma 1988

Table 9.7 Estimation of crop losses caused by insect pests to major agricultural crops in India. (Source: Dhaliwal et al. 2010)

Crop	Actual production[a] (million tons)	Approximate estimated loss in yield		Hypothetical production in the absence of losses (million tons)	Monetary value of estimated losses in millions of US $
	–	Percentage	Total (million tons) –	–	
Cotton	44.03	30	18.9	62.9	6,877.80
Rice	96.7	25	32.2	128.9	4,862.57
Maize	19	20	4.8	23.8	596.33
Sugarcane	348.2	20	87.1	435.3	1,430.94
Rapeseed-mustard	5.8	20	1.5	7.3	528.50
Groundnut	9.2	15	1.6	10.8	509.57
Other oilseeds	14.7	15	2.6	17.3	752.95
Pulses	14.8	15	2.6	17.4	881.87
Coarse cereals	17.9	10	2.0	19.9	241.63
Wheat	78.6	5	4.1	82.7	837.66
Total/Average	–	17.5	–	–	17,492.84

[a] Production and minimum support price (MSP) fixed by Government of India for 2007–2008. Adapted from Anonymous (2010)

There has been a paradigm shift in crop management in Indian agriculture since the beginning of this century. Bt cotton was released in the country in 2002 and the area under Bt cotton increased from 50,000 ha in 2002 to 8.4 million ha in 2009. Of the estimated 9.6 million ha of cotton in India, 87% was under Bt cotton in 2009 (James, 2009). Second, concerted efforts were made to implement integrated pest management programs in principal food and cash crops. As a result of these developments, losses due to insect pests in several agricultural crops are declining (Table 9.7). However, in terms of monetary value, the decline in losses does not appear to be significant. This is due to both the increase in production levels and the increase in prices of different commodities.

It is imperative to contain these colossal losses, year after year, in order to meet the rising demand for food grains and other agricultural commodities. Moreover, this has to be done in such a way that environmental quality is maintained and long term sustainability of the agro ecosystem does.

9.4 Conclusions

The global losses due to insect pests, diseases and weeds have increased tremendously during the last 2–3 decades, despite the fact that high priority has been given to crop protection measures. Although the Green Revolution technology substantially increased the yields per unit area, in many regions the crop protection technology failed to keep pace with the increase in intensity of cultivation. The sole dependence on pesticides led to rapid development of pesticide resistance among insect populations and has resulted in outbreaks of pests in many crops. The developments of other methods of pest control did not keep pace with the need for pest control. As cultivation becomes more intensive, there should be a commensurate improvement and intensification of the measures taken to protect the crops. During the last decade, spectacular progress has been achieved in the development of biological control strategies, insect-resistant crop plants and genetically engineered crops. All these measures suitably employed in the integrated pest management (IPM) system along with improvements in crop protection extension services should lead to a substantial reduction in crop losses due to pests.

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