

Hill-farming in Himalayas

Another enemy in fray

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The Himalayan region of Himachal Pradesh, recently devastated by flash floods, now faces another threat—the invasion of the Fall Armyworm (FAW). Originating from the Americas, FAW has rapidly spread across continents, reaching Africa, Asia, Australia, and even New Zealand. In India, its presence was first detected in 2018, with subsequent reports from all states except Himachal Pradesh and Jammu and Kashmir. However, in 2020, FAW infested maize crops in Himachal Pradesh's Una district, posing a significant threat to the region's agriculture-dependent livelihoods and food security. This article highlights the challenges posed by FAW in Himachal Pradesh, emphasizing the urgent need for effective management strategies to mitigate crop losses and safeguard agricultural sustainability in the face of this invasive pest.

Keywords: Fall armyworm, Hill, Himachal Pradesh, Himalaya, Pest

THE latest stint of nature's vagaries on North-West Indian Himalayan state and valley of gods has devastated Manali. The flash floods are barely over and basic facilities like roads, electricity and mobile networks are still getting restored. The maize farmers in Himachal Pradesh are struck with another and relatively new invasion by the ever so dreaded and destructive Fall Armyworm (FAW) posing a serious malady for many crop plant grown in the otherwise a relatively fragile Himalayan ecosystem. The FAW is fast transforming as a potential threat not only to cereals like maize but owing to its polyphagous nature, ability to fly over long distances per night, and a shorter life cycle of just 30 days on maize necessitates to deal with it on priority.

Spread and distribution

FAW is a ferocious villain bothering the farmers and ecologists. It is an invasive pest of the Americas, native to the tropical regions of the Western Hemisphere

from the United States to Argentina. In the continent of Africa, FAW was first detected in Central and Western Africa in early 2016 (Sao Tome and Principe, Nigeria, Benin and Togo) and in late 2016 and 2017 in Angola, Botswana, Burundi, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Namibia, Niger, Rwanda, Sierra Leone, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. As per reports, in Asia, the FAW, probably invaded Yemen at first and then the Indian subcontinent in 2018. By 2019, it migrated eastwards, to other parts of Asia such as China, South Korea, and Japan.

Recent reports have shown its invasion to the far and wide corners of the world including parts of Australia (in Queensland in February 2020) as well as New Zealand (thought to have been carried on winds from Australia) where the laws of land related to biosafety/security are relatively stringent, it was first reported in 2022 in the North Island.

Status in India

In India on 18th May 2018, the FAW was first noticed in a research centre on maize in Shivamogga district of Karnataka. Within a year, it was reported from all the Indian states except Himachal Pradesh and Jammu and Kashmir.

In Himachal Pradesh, the incidence of FAW was noted for the first time in the maize crop in Una district, which borders with the state of Punjab during *kharif* season 2020. The pest has proved its viciousness by its fast spatial distribution over almost all the states of the country, besides, by infestation over a wide range of host crops by 2023. Its spread has been reported from other parts of the state too, with the agriculture department distributing pesticides at the block level in various districts to arrest its spread and damage to the maize crop. Agriculture and its allied activities are integral to the lives and livelihoods of most of the people in the State. Besides, the fact that the sector helps in ensuring food security, it also provides livelihoods to more than half of the state's

Table 1. Incidence of *Spodoptera frugiperda* on maize crop in India

State	First Report
Karnataka	May, 2018
Tamil Nadu, Telangana, Andhra Pradesh	July, 2018
Maharashtra, Chhattisgarh, Madhya Pradesh	August, 2018
Gujrat	September, 2018
Bihar, West Bengal, Rajasthan	October, 2018
Kerala	December, 2018
Tripura and Mizoram	March, 2019
Nagaland	April, 2019
Manipur, Meghalaya, Arunachal Pradesh, Sikkim	May, 2019
Assam, Jharkhand, Uttar Pradesh	June, 2019
Uttarkhand, Delhi	July, 2019
Haryana, Punjab	August, 2019

workforce i.e. 57.03%. Himachal Pradesh ranks 17th State in India with a geographical area of 55,673 square kilometers (Sq Km). Out of the total geographical area, 9.75% of area comes under the net sown area. Rainfed agriculture accounts for approximately 80% of the farm land in the state. Rice, maize, and wheat are the state's main cereal crops. Agro climatically, the state is divided into four zones: (i) Sub Tropical, sub- montane and low hills, (ii) Sub Temperate, sub humid mid hills, (iii) Wet temperate high hills, and (iv) Cold deserts. Maize, a rainfed crop, is grown in an area of 295,000 ha with the production of 540,000 tonnes and productivity of 1.8 tonnes/ha. Hybrid maize is grown at lower altitudes. Maize can be grown over a wide environmental range. It is essentially a crop of warm countries with adequate moisture. Bulk of the crop is grown in warmer parts of temperate regions and in humid subtropics. It is mainly grown from 50°N to 40°S and from sea level to 4000 m in Andes and Mexico. In Himachal Pradesh, the districts of Kangra, Mandi, Chamba, Una, Hamirpur, Solan, Bilaspur and Sirmaur provide ideal conditions in the *kharif* season for the cultivation of maize crop and therefore maize

Table 2. Production of major crops (in '000 Metric tonnes) in Himachal Pradesh in recent years

Crop	2019-20	2020-21	2021-22	2022-23	Percentage contribution to total 2022-2023
Maize	729.73	725.01	759.61	741.00	20.17
Wheat	627.96	575.57	643.93	617.00	16.80
Paddy (Rice)	143.66	138.46	199.05	143.00	3.89
Pulses	54.81	50.23	60.09	57.00	1.55
Barley	30.83	29.01	25.89	29.00	0.79
Millet & Bajra	4.77	2.15	2.63	4.50	0.12
Ragi	2.06	0.49	0.49	2.01	0.05
Gram	0.42	0.34	0.34	0.41	0.01

is the primary cereal crop in these areas.

Unlike the previous years, in 2023-24, the farmers' in Himachal Pradesh are facing a double threat, the heavy rains triggering flash floods (a total of sixty-one landslides and 44 flashfloods have been reported in the state since the onset of monsoon on June 24 till July 24), water logging in the fields and the fall army worm infestation. A crop loss of 25-30% has already been reported from independent sources in Una, Mandi, Kangra and Hamirpur districts, with losses over ₹25.65 crores in Una district alone.

Pest biology

The polyphagous nature with an ability to feed over 353 plant species, ability to fly 100 km per night, and a shorter life cycle of just 30 days on maize (in warm summer months); in cooler temperatures, it may extend up to 60–90 days and a preference to areas of high humidity and moderately high temperatures sometimes even leading to intensification of infestation. All these gruesome qualities when found in a single pest, it makes the pest even more dreaded. This makes FAW a highly notorious pest that is not only threatening the livelihood of the farmers but is also a serious



FAW infestation on maize

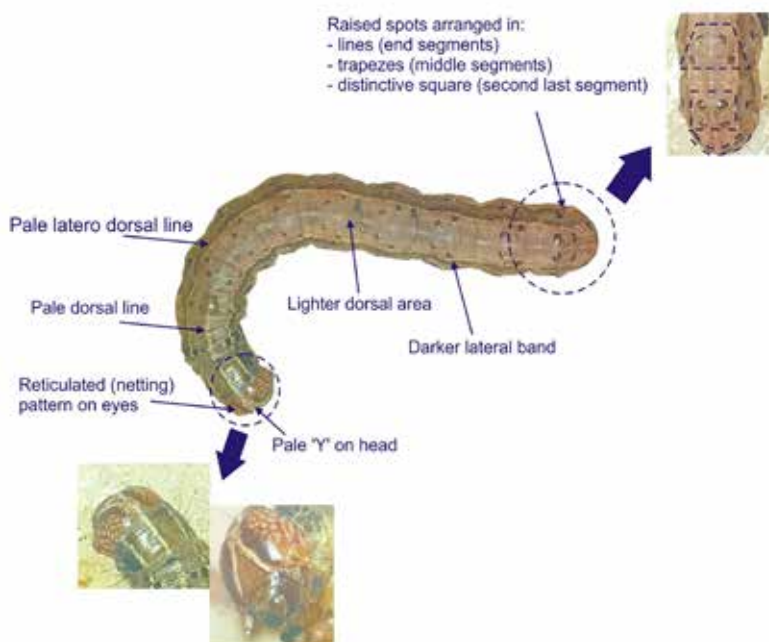
blow to the government's natural and organic farming initiatives in the state and the country, threatening the food security in the changing climate. FAW adults can travel up to 100 km in a night during summer. They are excellent fliers and may migrate up to 500 km before laying eggs. These are also known to travel long distances on stormfronts. Mature larvae can migrate when they reach the armyworm stage and migrate to adjacent crops. Mature FAW larvae have several distinct features, such as a dark head with an upside down, pale Y-shaped marking, four raised spots shaped like a trapezium on each body segment seen from above and four spots forming a square on the second-to-last body segment.

FAW host range

In India, FAW has emerged as serious pest on maize, sorghum, finger millet, sugarcane, cotton, and it has potential to spread on other important cereal crops such as *Oryza sativa* L. (rice), *Triticum aestivum* L. (wheat), *Fagopyrum esculentum* Moench (buckwheat), *Secale cereale* L. (rye), *Setaria italica* L. *P. Beauv.* (foxtail millet); fruit crops like *Mangifera indica* L. (Mango) *Carica papaya* L. (papaya), *Ficus carica* L. (fig), *Citrus aurantium* L. (sour orange), *Citrus limon* L. *Burm.* *F.* (lemon), *Citrus reticulata* Blanco ssp. *Unshiu*, *Citrus paradisi* Macfad. (grapefruit), *Citrus reticulata* Blanco (tangerine), *Citrus sinensis* L. Osbeck (sweet orange), *Musa paradisiaca* L. (banana), *Prunus persica* L. Batsch (peach), *Pyrus communis* L. (pear), *Fragaria ananassa* Duchesne

Fall armyworm

(*Spodoptera frugiperda*)



whorl of affected maize plants soon after observation of FAW incidence; Sand + lime in 9:1 ration in whorls in first 30 days of sowing and using FAW specific pheromone traps @ 15/acre. In addition, bio-control measures can also be followed: *In situ* protection of natural enemies by habitat management; release of egg parasitoid *Trichogramma pretiosum* or *Telenomus remus* @ 50,000 per acre at weekly intervals; Bio-pesticides *Metarhizium anisopliae*, *Metarhizium rileyi* (*Nomuraea rileyi*), *Beauveria bassiana*, *Verticillium lecani* (1×10^8 cfu/g) @ 5g/litre whorl application can also be done if infestation level is 5% in seedling to early whorl stage and 10% ear damage. The chemical control can be achieved by application of Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg as seed treatment; Spinetoram 11.7% SC or Chlorantraniliprole 18.5% SC or Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC in mid whorl to late whorl stage (https://ppqs.gov.in/sites/default/files/faw_do.pdf)

The appropriate collaborative measures are required to be initiated to contain the spread of FAW, before it breaks the barriers across the crop species and geographical locations among different regions of the state otherwise, we are already facing yet another such pest in the form of fruit fly, which is still uncurbed. Single management strategy for FAW may not prove effective. Hence, integrated approach combining mechanical, bio-control, traps, cultural methods and chemical control should be adopted, so that, if we do not attain full control, even the farm economy remains viable and the ecological and environmental sustainability is ensured at the same time.

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(cultivated strawberry); vegetable crops like *Brassica oleracea* var. *botrytis* L. (broccoli), *Brassica oleracea* var. *capitata* L. (cabbage), *Brassica rapa* L. var. *rapa* L. (field mustard), *Cucumis melo* L. (melon), *Cucumis sativus* L. (cucumber), *Cucurbita maxima* Duchesne (pumpkin), *Abelmoschus esculentus* L. Moench (okra), *Solanum lycopersicum* Mill. (tomato), *Solanum melongena* L. (eggplant), *Solanum tuberosum* L. (potato), *Zingiber officinale* Roscoe (ginger); cash crops like *Aloe vera* L. (aloe), *Coffea arabica* L. (coffee), *Nicotiana tabacum* L. (tobacco), several species of grasses and ornamental flowers. When in large numbers, they consume nearly all vegetation in their path. In Himachal Pradesh, their spread hasn't been reported on other crops yet, but due to its polyphagous nature and climate change scenario, it can soon emerge as a serious pest of the horticultural crops as well.

Management perspective

Early detection of FAW offers the best opportunity for effective management. Monitoring can be done by regular crop inspection (along the row, 'W' shaped pattern), combined with the use of pheromone traps. Cultural measures include: deep ploughing before sowing to expose the pupae to predators; intercropping with suitable pulse crops, oil seeds, ornamental plants to build up natural enemy population; erection of bird perches @ 10/acre; Sowing of 3-4 rows of trap crops (eg. Napier) and spray with 5% NSKE or azadirachtin 1500 ppm as trap crop shows symptom of FAW damage; clean cultivation and balanced use of fertilizers. Mechanical measures mainly involve: Hand picking and destruction of egg masses and neonate larvae by crushing or immersing in kerosene water; application of dry sand in to the

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