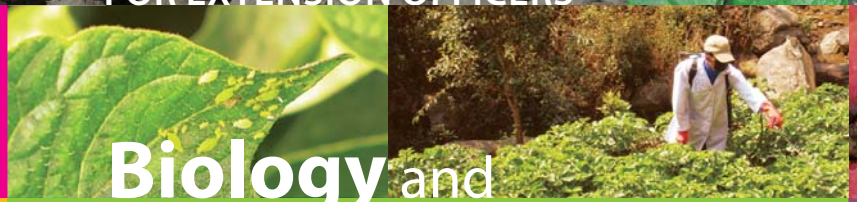



TRAINING GUIDE
FOR EXTENSION OFFICERS



Biology and management of potato insect pests in Nepal

YAGYA P. GIRI • NARESH DANGI • SUNIL ARYAL • MARC SPORLEDER
SUCHITRA SHRESTHA • CHANDRA BAHADUR BUDHA • JÜRGEN KROSCHEL

CENTRO • INTERNACIONAL • DE LA PAPA •
CIP
A member of the CGIAR Consortium

NEPAL AGRICULTURAL RESEARCH COUNCIL
NARC

TRAINING GUIDE
FOR EXTENSION OFFICERS

Biology and management of **potato insect pests** in Nepal

YAGYA P. GIRI • NARESH DANGI • SUNIL ARYAL • MARC SPORLEDER
SUCHITRA SHRESTHA • CHANDRA BAHADUR BUDHA • JÜRGEN KROSCHEL

Biology and management of potato insect pests in Nepal. Training guide for extension officers

ISBN: 978-92-9060-426-6
DOI: 10.4160/978-92-9060-426-6

This work was a joint collaboration of NARC (Entomology Division, NARC, Khumaltar, Lalitpur, Nepal) and CIP, funded by Austrian Development Agency (ADA), Austria.

Authors: Yagya P. Giri (Principal Scientist, Nepal Agricultural Research Council), Naresh Dangi (Technical Officer, Entomology Division, Nepal Agricultural Research Council) Sunil Aryal (Technical Officer, Entomology Division, Nepal Agricultural Research Council), Marc Sporleder (Regional Project Coordinator, sub program Agroecology/IPM, CIP) Suchitra Shrestha (Research Associate, CIP), Chandra Bahadur Budha (Research Assistant, CIP), Jürgen Kroschel (Science Leader sub-program Agroecology/IPM, CIP)
Photos: Naresh Dangi, Sunil Aryal, Marc Sporleder, Jürgen Kroschel
Art work: Naresh Dangi, Chandra Bahadur Budha

Produced by the CIP Communication and Public Awareness Department (CPAD) and Nepal Agricultural Research Council (NARC), Entomology Division

Production coordinator: Cecilia Lafosse
Design and layout: Nini Fernández-Concha

Copies 300
January 2013



What we are going to learn?







1

General consideration of the course

A warm welcome to this training course on "Biology and management of potato insect pests in Nepal". Insect pests are important biotic constraints affecting and limiting potato production in Nepal. Depending on the level of infestation, losses in terms of quality and quantity can easily reach up to 60%, which seriously affects the income of subsistence farmers.

This training course is intended for extension officers and IPM facilitators involved in potato production. An understanding of the biology and ecology of pests is essential for the proper use and implementation of control strategies. Our goal is to share information in order to update your knowledge to control potato pests effectively. Also, learn to perform cost-benefit calculations by the use of eco-friendly practices as an alternative to chemical pesticides.
The concept of training is based on a close connection between theory and practice in field demonstrations and calculation exercises.

We hope that with your participation we can achieve the objectives to better manage our crops in a healthy and sustainable way.







Why do we have problems with insect pests?

2

Agricultural intensification and global warming

- Fragmentation of agricultural landscapes
- Changing cropping pattern
- Monoculture cropping systems with reduced fallow periods
- Reduction of natural vegetation and niche areas for natural enemies
- Intensive use of pesticides that affect the natural enemies of pests and cause the development of secondary pests
- Newly introduced pests which have no specific natural enemies

Structurally rich landscape

Structurally poor landscape

Are all insects pests?

- Most insects are beneficial.
- Only some have become pests in agriculture, feeding on crops or harvest products.
- Pests are especially damaging crops when they occur in large quantities.
- Production of their main host plants on large-scale favors pests development and damage.
- Economic damage begins to occur occur when control costs for suppressing the insect injury are equal to the potential monetary loss from a pest population.

Climate change and global warming

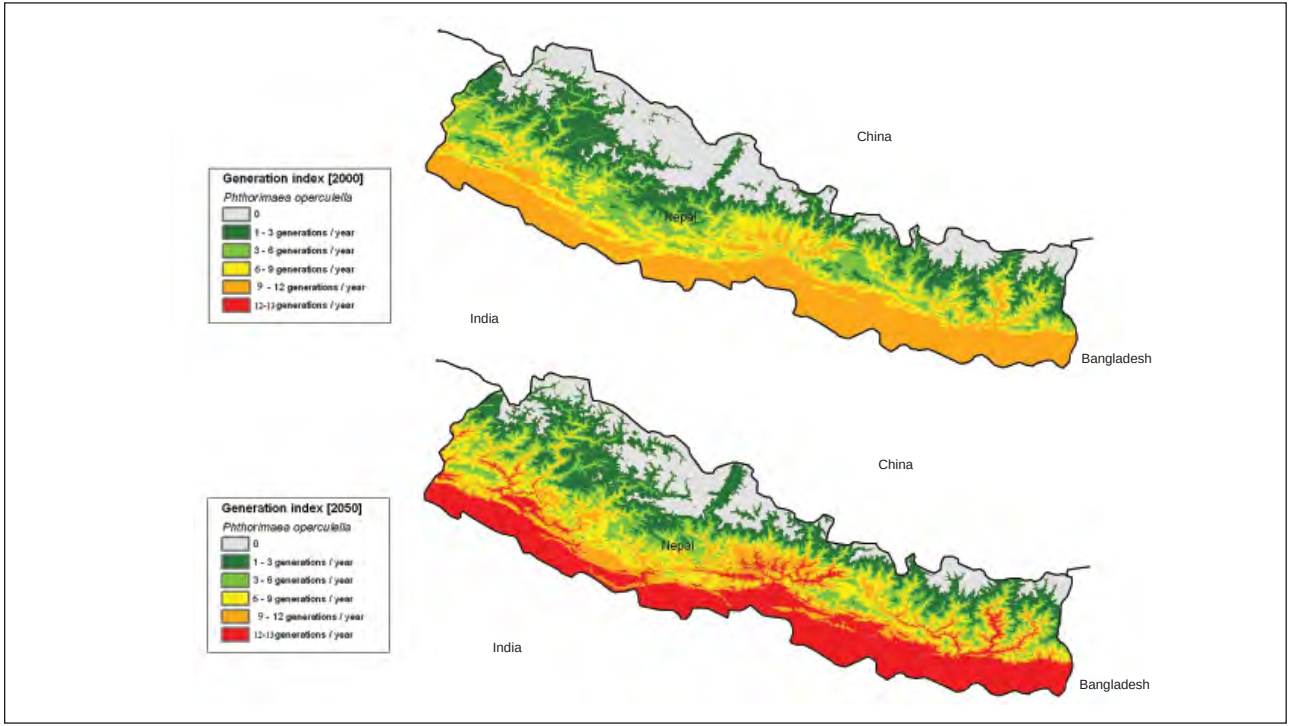
- The development of insects is strongly determined by temperature.
- Increasing temperature shortens the development time of insects and hence produces more generations with higher numbers of individuals per year.
- As a result, pests are spreading to higher altitudes in the Himalaya region and cause more damage to crops.

Climate change and global warming

Expected current and future numbers of generations produced by the potato tuber moth (PTM), *Phthorimaea operculella* (Zeller), in selected potato production locations in Nepal.

		Generation/year				
	Avg. annual	**2010**	**2030**	**2050**	**2080**	**2100**
Location	**temp (°C)**	**T°C actual**	**+ 1°C**	**+ 1.6°C**	**+ 2.4°C**	**+ 2.8°C**
Tukucha, Kavreplanchowk	19.4	7.3	8.1	8.6	9.2	9.6
Phikal, Ilam	19.6	7.7	8.6	9.1	9.8	10.2
Charpane, Jhapa	26.1	13.9	14.9	15.6	16.4	16.8
Phulbari, Kailali	24.0	12.6	13.56	14.2	15.0	15.4

Generation index for PTM expected according to temperature in Nepal in 2000 and due to climate change in 2050









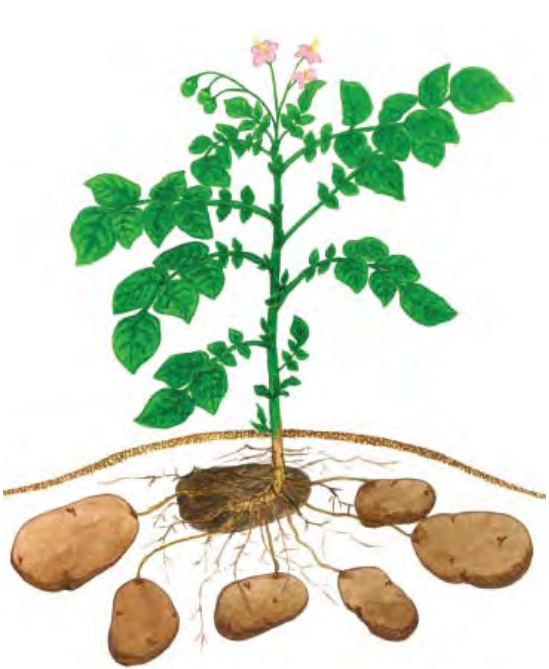
Which insect pests are attacking potato in Nepal?

3

Major potato pests in the Nepal

	Potato tuber moth	आलुको पुतली
	Red ant	रातो कमिला
	Green peach aphid	आरुको हरियो लाई
	White grubs	खुम्रे कीराहरु
	Leafminer fly	पात खन्ने झिङ्गा
	Cut worm	फेद कटुवा
	Cotton boll worm	कपासको फलमा लाग्ने गवारो
	Semi-looper	वित्ता नाप्ने कीरा
	Epilachna beetle	थोप्ले खपटे
	Black blister beetle	कालो कागे खपटे
	Flea beetle	उपिया जस्तो खपटे कीरा
	Wire worm	सुईरो जस्तो लामो खपटे

Potato pests attacking potato foliage and tubers



Leafminer fly

Epilachna beetle

Semi-looper

Potato tuber moth

Wire worm

Red ant

Flea beetle

Cotton boll worm

Black blister beetle

Green peach aphid

Cut worm

White grubs

Potato tuber moth

Phthorimaea operculella (Zeller) (Lepidoptera: Gelechiidae)

Alu ko Putali/Jotaha Kira (आलुको पुतली/आलुको जोताहा कीरा)

Larva L_1 to L_4
(L_4 measures about 9-13 mm)

Pupa
(about 6-7 mm long)

Adult
(about 7-9 mm long)

Red ant

Dorylis orantalis Westwood (Hymenoptera: Formicidae)

Rato Kamila (रातो कमिला)

Worker
(about 3-7 mm)

Workers

Male
(wing span 32-33 mm lengths 25-28 mm)

White grubs

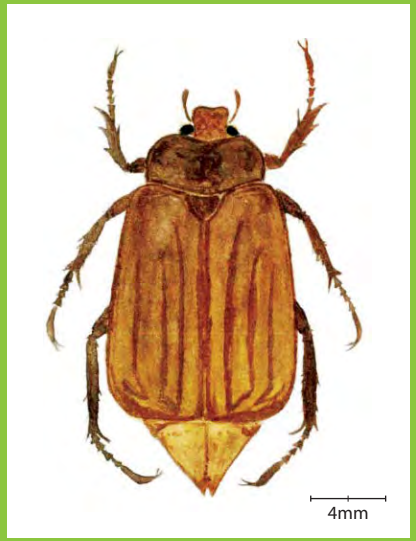
Different species (*Melolantha* sp., *Anomala* sp. a.o.) (Coleoptera: Scarabaeidae)

Khumre kira/Khurmaulo/Gandra/Bamselu/Kamuwa (खुम्रे कीरा/खुर्माउलो/गन्ड्रा/बम्सेलु/कमुवा)

For example: *Melolantha melolantha*

Larva L_1 to L_6
(L_6 measures about 40-50 mm)

Pupa



Adult
(body length 23-30 mm)

Green peach aphid

Myzus persicae (Suzler) (Hemiptera: Aphididae)

Aaru ko hariyo laii (आरुको हरियो लाई)

Myzus persicae adults and nymphs

Myzus persicae adults

Leafminer fly

Liriomyza huidobrensis Blanchard (Diptera: Agromyzidae)

Paat khanne jhinga (पात खन्ने झिङ्गा)

Maggot
(about 3.25 mm long)

Pupa
(about 1.3-2.3 mm long)

Adult
(body length about 1.3-2.3 mm)

Cut worms

Agrotis ipsilon (Hufnagel) (Lepidoptera: Noctuidae)

Phed katuwa kira (फेद कटुवा)

Larva
(about 45 mm long)

Pupa
(about 20-30 mm long)

Adult
(wing span 40-45 mm)

Cotton boll worm

Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae)

Kapas ko fal ma lagne gabaro (कपासको फलमा लाग्ने गबारो)

Larva
(about 30-40 mm long)

Pupa
(about 14-18 mm long)

Adult
(wing span 35-40 mm)

Semi-looper

Thysanoplusia orichalcea (Fabricius) (Lepidoptera: Noctuidae)

Bitta napne kira (बित्ता नाप्ने कीरा)

Larva
(about 35 mm long)

Pupa
(about 14-18 mm long)

Adult
(wing span 30-35 mm)

Epilachna beetle

Epilachna vigintioctopunctata (Fab.) (Coleoptera: Coccinellidae)

Epilachna/Thople Khapte [थोप्ले (ईपिलाक्ना) खपटे]

Eggs
(size about 1.09×0.44 mm)

Larva
(about 6 mm long)

Adult
(5-8 mm)

Black blister beetle

Epicauta hirtipes Waterh (Coleoptera: Meloidae)

Kalo Kage khapate (कालो कागे खपटे)

Larva

Pupa

Adult
(≈ 12 mm long)







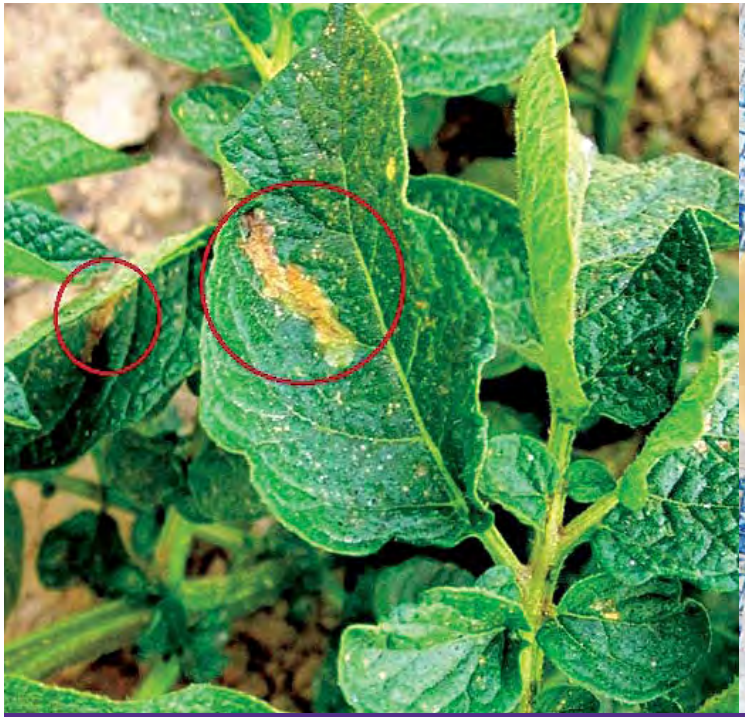
4

Which damage is caused by insect pests and what are the **economic losses?**

Damage in foliage and tubers

Potato tuber moth

Phthorimaea operculella (Zeller) (Lepidoptera: Gelechiidae)



Leaf damaged due to mining larvae

Tuber infestation in field

Tuber damage in storage

Slices of damaged tubers

Tuber damage

Red ants

Dorylus orientalis (Westwood) (Hymenoptera: Formicidae)

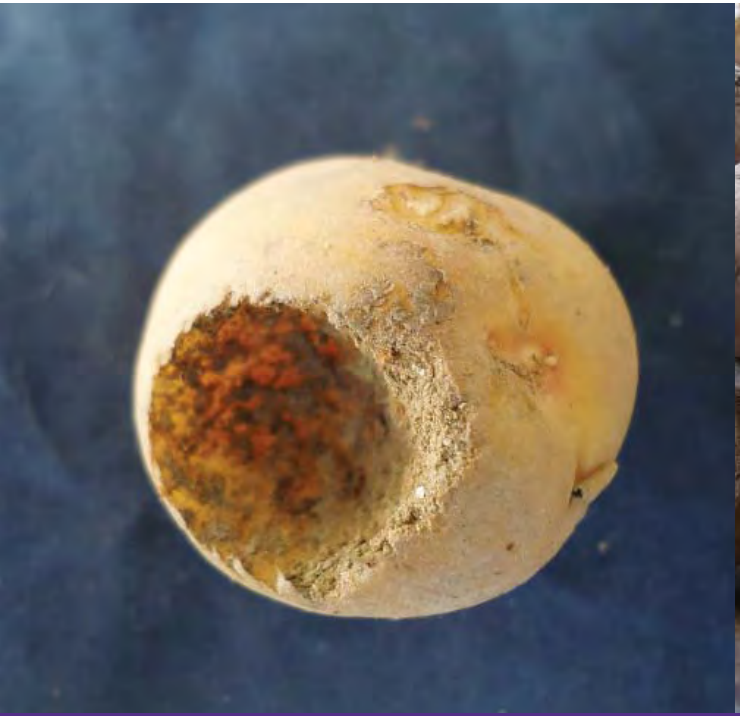
Damaged tuber

Damaged tuber

Tuber damage

White grubs

(different species) (Coleoptera: Scarabaeidae)



Damaged tuber in laboratory

Damaged tuber in field

Foliage and secondary damage due to virus transmission

Green peach aphid

Myzus persicae (Suzler) (Hemiptera: Aphididae)

Aphids

Virus infected

Foliage damage

Leafminer fly

Liriomyza huidobrensis Blanchard (Diptera: Agromyzidae)

Damaged leaflet

Damaged leaf

Damaged plant

Damaged field

Tuber damage

Cut worm

Agrotis ipsilon (Hufnagel) (Lepidoptera: Noctuidae)

Damaged tuber

Damaged tubers during harvest

Foliage damage

Cotton boll worm

Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae)

Damaged plant

Damaged plant

Damaged plant (total leaf loss due to larval feeding)

Damaged field

Foliage damage

Semi-looper

Thysanoplusia orichalcea (Fabricus) (Lepidoptera: Noctuidae)

Larva with damaged leaflet

Damaged leaves

Damaged plant

Damaged leaves

Foliage damage

Epilachna beetle

Epilachna vigintioctopunctata (Fab.) (Coleoptera: Coccinellidae)

Larval damage

Damaged leaf

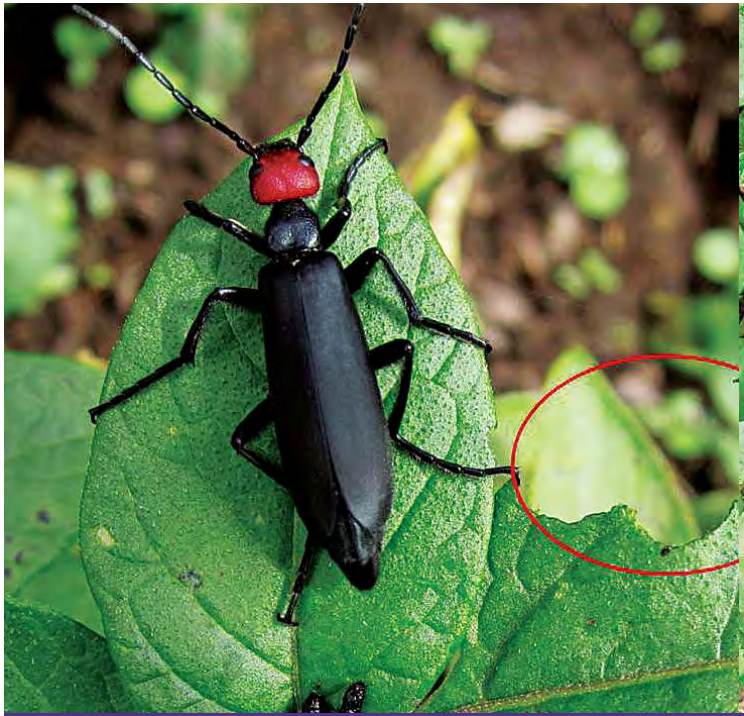
Damaged plant

Damaged field

Foliage damage

Black blister beetle

Epicauta hirtipes Waterh. (Coleoptera: Meloidae)



Damaged leaf

Damaged plants

How much do we lose?

Potato pest	Pre-harvest tuber/foliage damage (%)	Post harvest tuber damage (%)	Yield reduction (%)
Potato tuber moth	<5 (initial damage)	>40 to 100	up to 100
Leafminer fly	Foliage damage	-	>20
White grubs	>20-80	-	up to 80
Red ants	20-60	-	up to 60
Other lepidopteran pests	Occasional outbreaks	-	>20
Aphid	Foliage damage and virus transmission		
Black blister beetle	Foliage damage		
Epilachna beetle	Foliage damage		



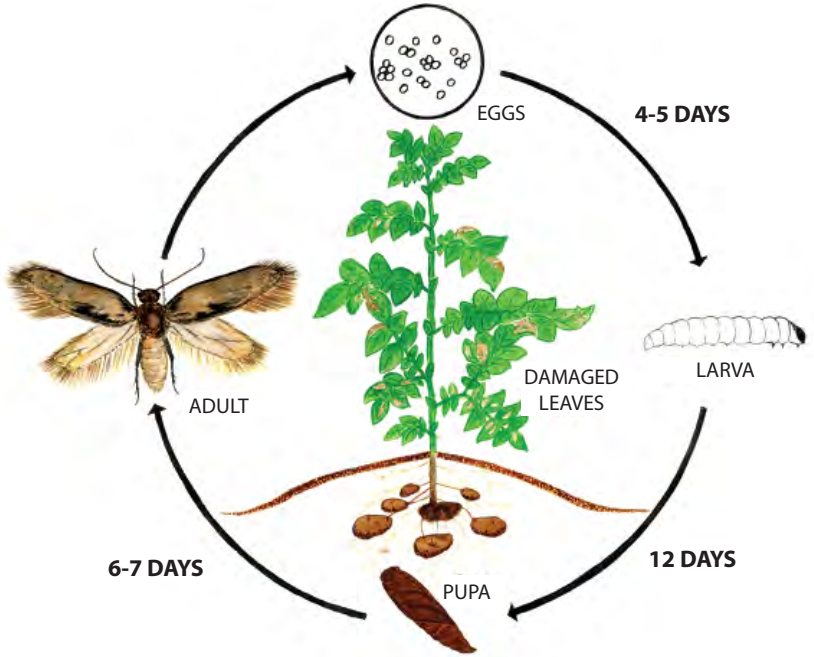




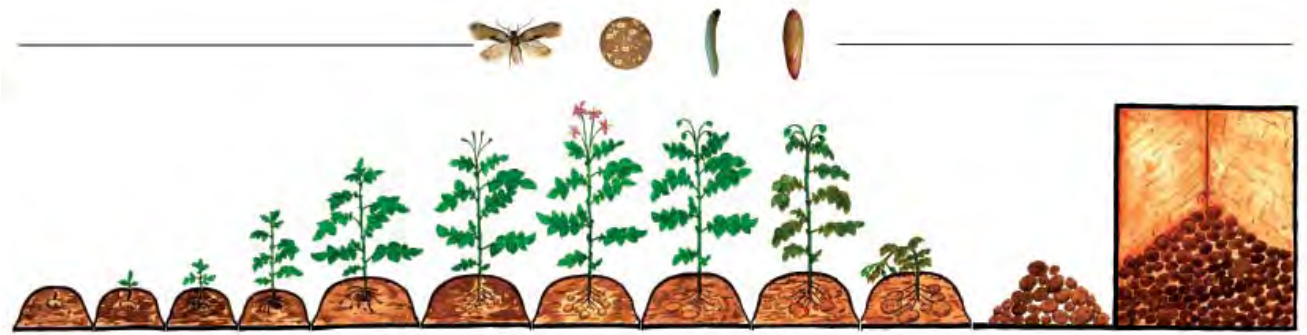
5

How do the insect pests live?

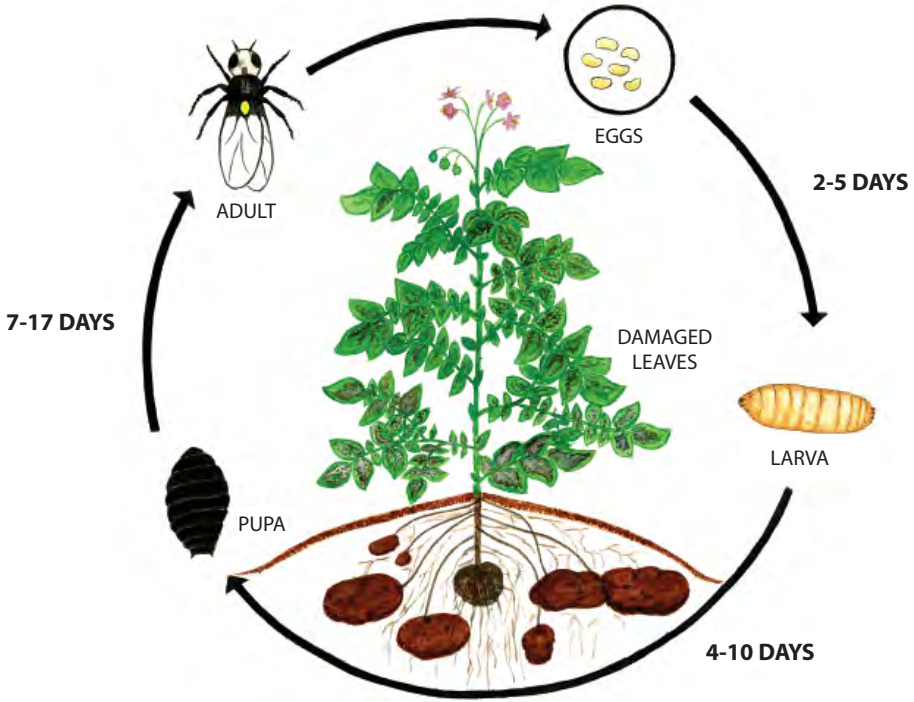
Life cycle of potato tuber moth



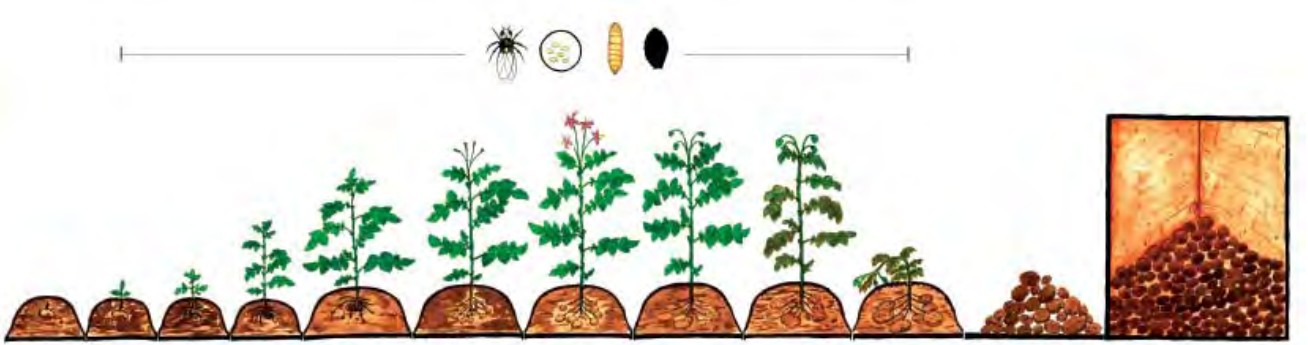
Phenology of the potato crop and presence of potato tuber moth life stages in the field and storage



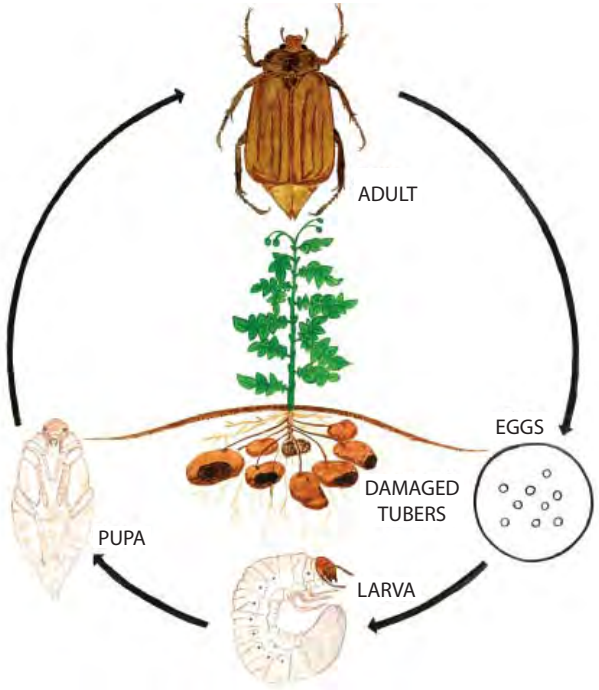
Life cycle of leafminer fly



Phenology of the potato crop and presence of leafminer fly life stages in the field

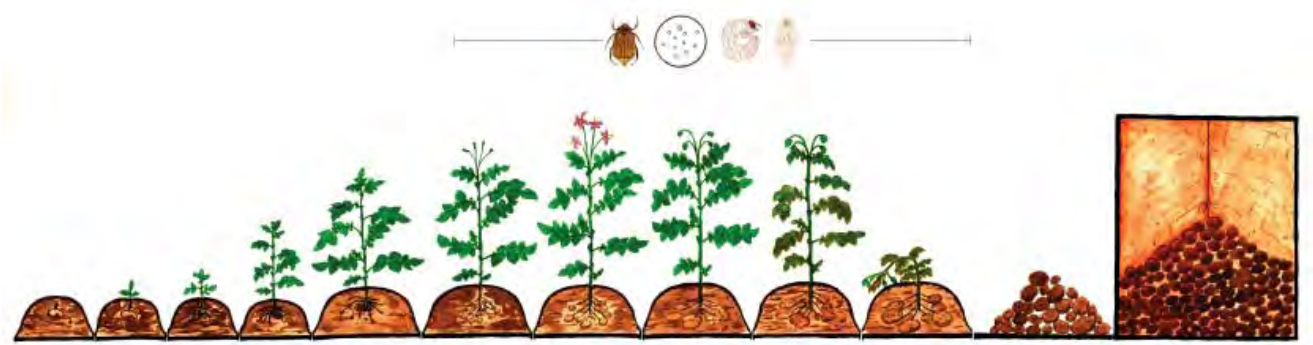


Life cycle of white grub

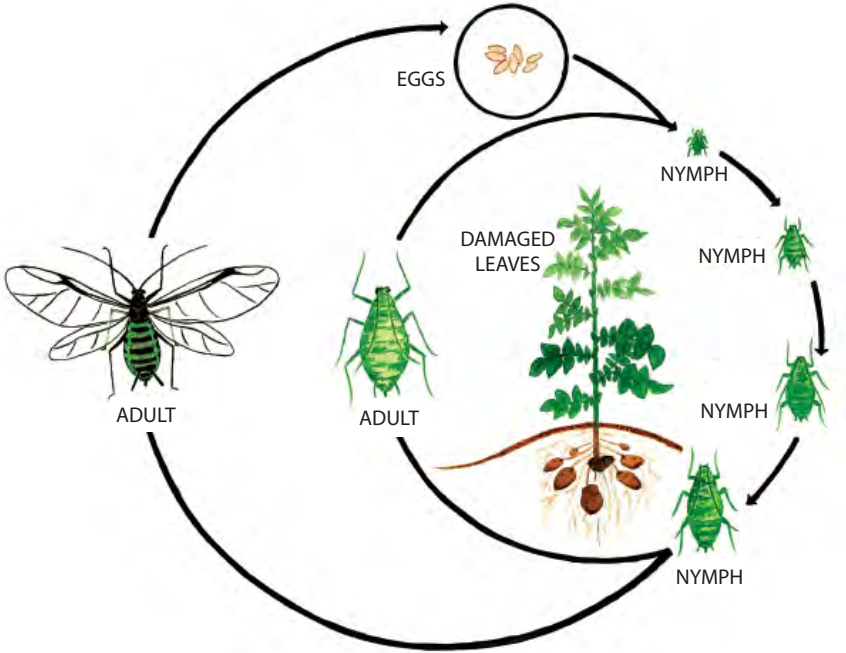


Life cycle varies among the species from 1 to 3 years. For example, *M. melolantha* takes 3-4 years to complete its life cycle

Phenology of the potato crop and presence of white grubs life stages in the field

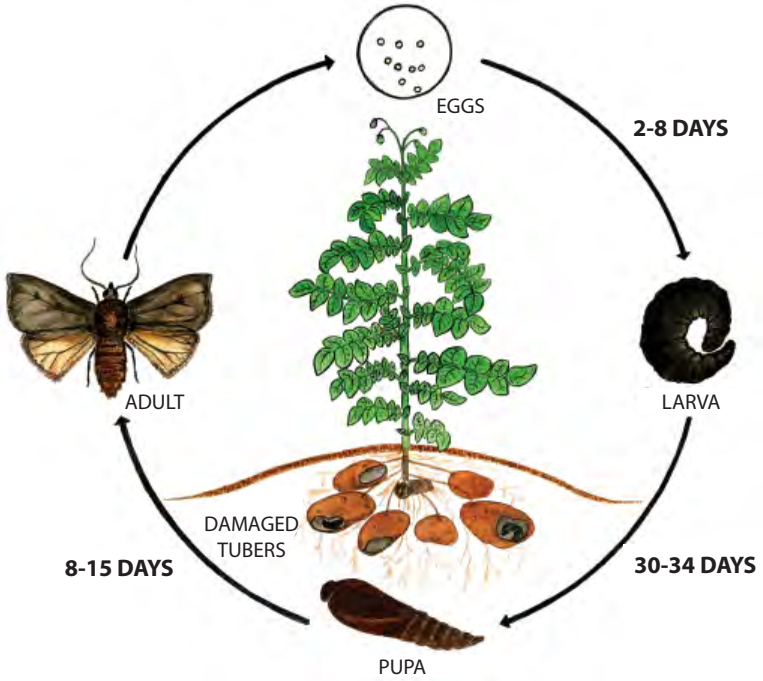


Life cycle of the green peach aphid

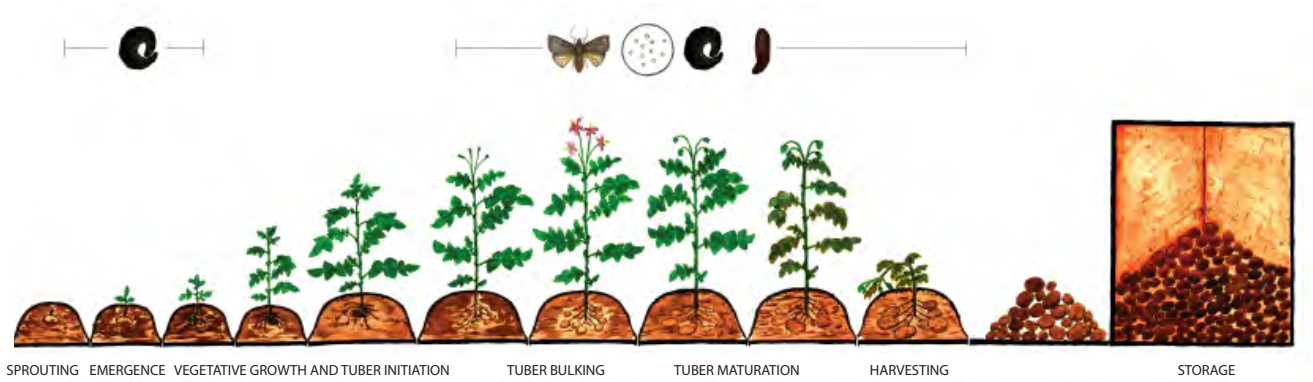


Complete life cycle takes 12-22 days

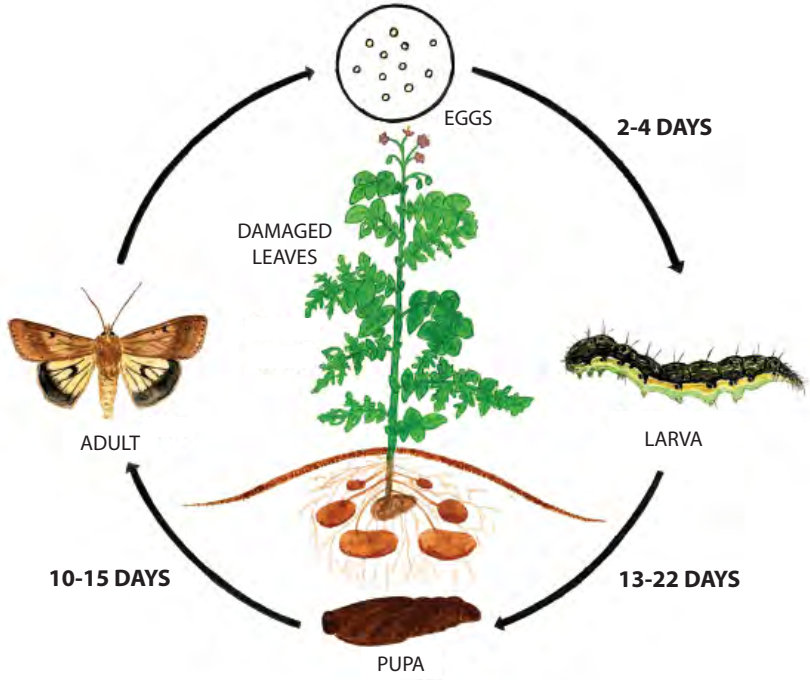
Life cycle of cut worm



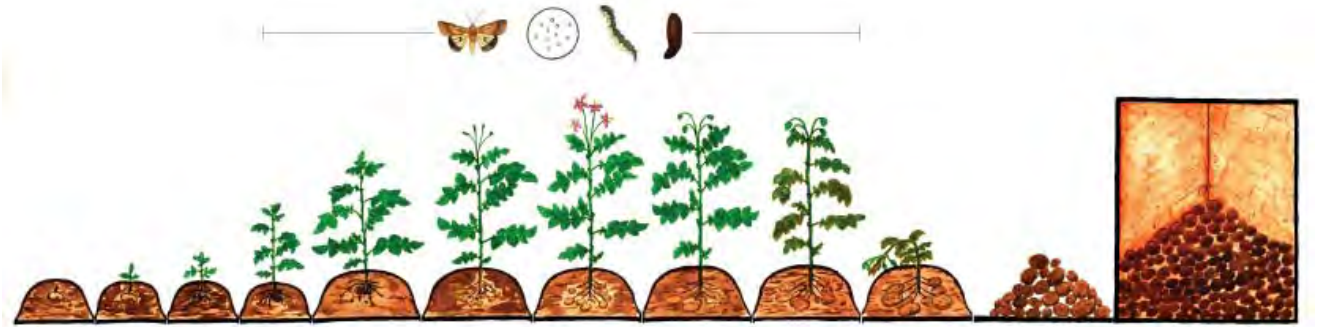
Phenology of the potato crop and presence of cut worm life stages in the field



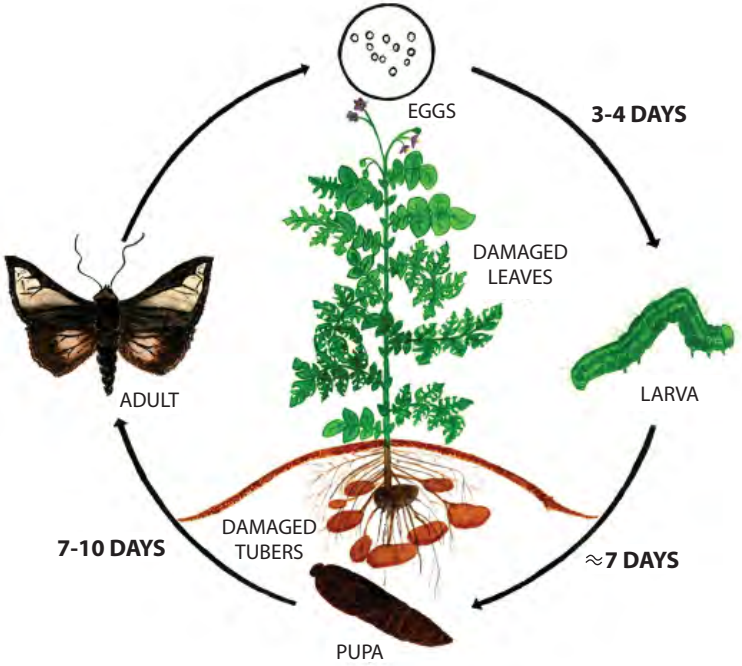
Life cycle of cotton boll worm



Phenology of the potato crop and presence of cotton boll worm life stages in the field

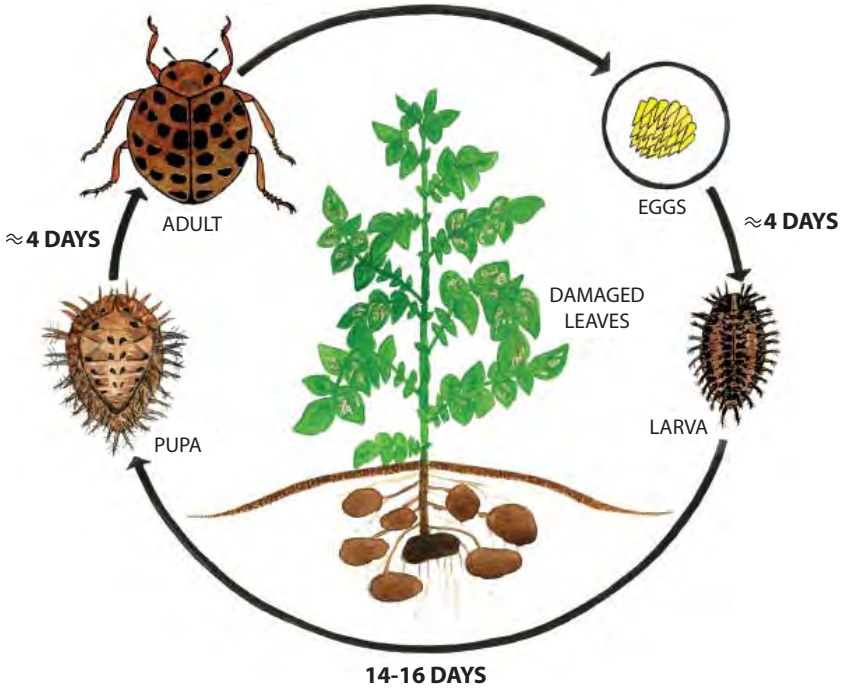


Life cycle of semi-looper

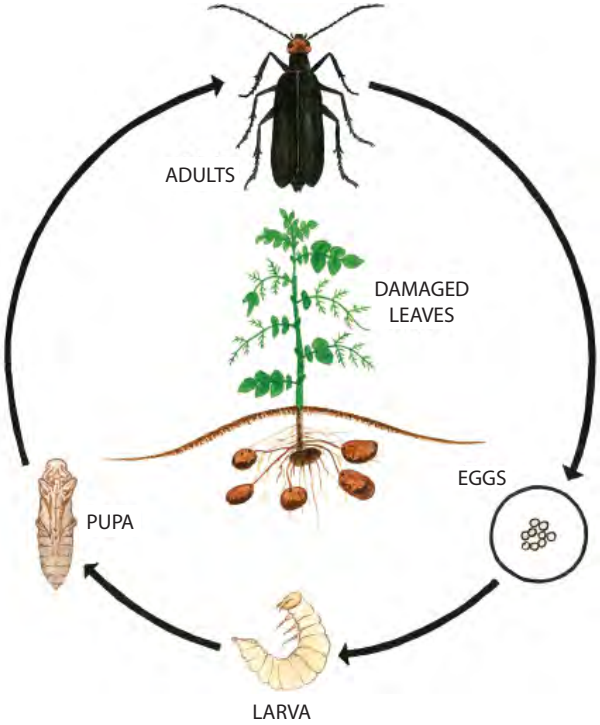


Phenology of the potato crop and presence of semi-looper life stages in the field

Life cycle of epilachna beetle



Life cycle of black blister beetle



Potato growing season and insect pest problem

- Three major potato growing seasons in Nepal
  - Rainy season, with planting in July-August
  - Winter season with planting in October
  - Spring season with planting in December-January
- Potato tuber moth is major problem during the spring potato season.
- Lepidopteran pests occur during the late vegetation period in the spring potato season.
- Leafminer fly is a pest in some mid-hill regions (e.g., Kavreplanchowk, Kathmandu valley) during the spring potato season.
- White grubs are major pests of mid-hill regions with potato harvest in June-July.
- Cut worm are pests during the sprouting stage and tuber bulking to harvesting stage. It cuts the potato sprouts and damages tubers.
- Black blister beetle can be damaging in some mid and high hill regions during the rainy season (e.g., Jumla, Dailekha).
- Epilachna beetle occurs during the rainy season (e.g., Kathmandu valley).

Insect pest problem according to the growth stage of potato in Nepal

Growth stage

Insect	
Potato tuber moth	
Red ant	
Green peach aphid	
White grubs	
Leafminer fly	
Cut worm	
Cotton boll worm	
Semi-looper	
Epilachna beetle	
Black blister beetle	
Flea beetle	
Wire worm	

Presence of pest and harmful
Presence of pest and not so harmful
Absence of pest

Ecological parameters for potato pests in Nepal

	PTM	LMF	White grub	Lepidopteran
Problem	Post harvest	Vegetation	Tuber initiation	Late vegetation
Agro-ecological zone/ Altitude	<2000 m (Terai and mid-hill)	700-2000 m (mid hill) (central region)	Different ranges depending on species	<2000 m (mid hill)
Temperature range	10-30 °C	10-25 °C	Variable depending on species	Variable depending on species
Host plant	Potato, egg plant, tomato	Potato, common bean, garden pea and other horticultural crops	Root crops, vegetables, cereals	Vegetables, cereals







6

How can we manage insect pests?

Definition of Integrated Pest Management (IPM)

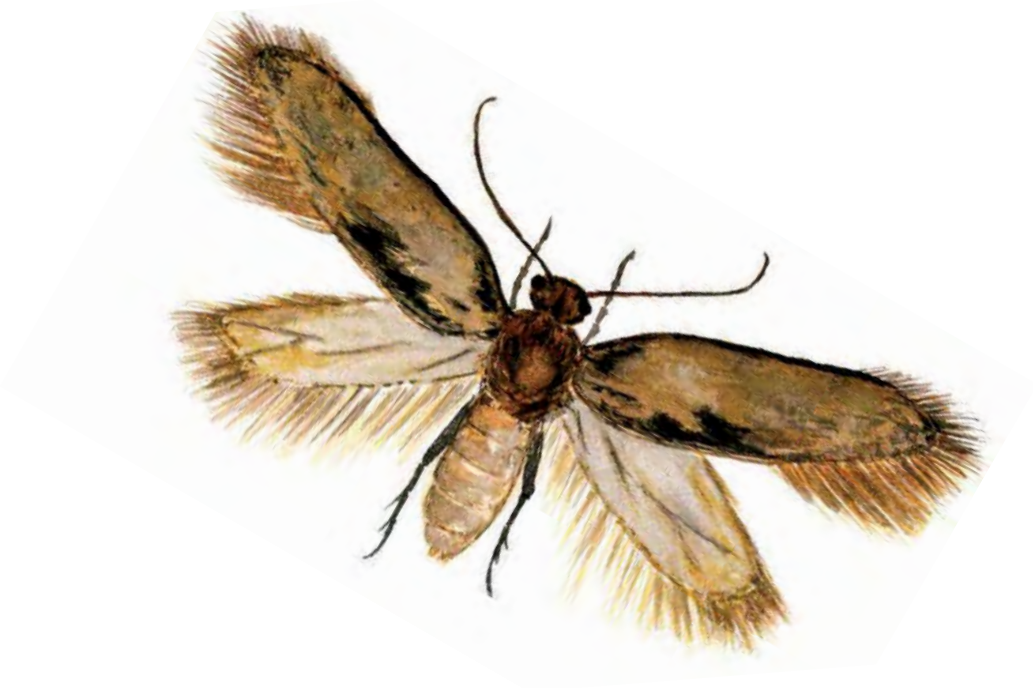
Integrated control is a pest management system that in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in a compatible manner as possible and maintains the pest populations at levels below those causing economic injury (FAO 1967)

Concept

IPM is an approach that considers the ecological and socioeconomic conditions of an agroecosystem as a unit, and strives to maintain sustainable productivity. It focuses on pest control using natural limiting factors and integration of techniques that prioritize the biological, biorational, breeding and cultural practices, restricting the use of chemical pesticides to a minimum.

Concept of Integrated Pest Management (IPM)

(Example of IPM concept for potato tuber moth control)



Cultural control in the field

- Use high quality seeds free from potato tuber moth infestation

Selection of healthy seeds

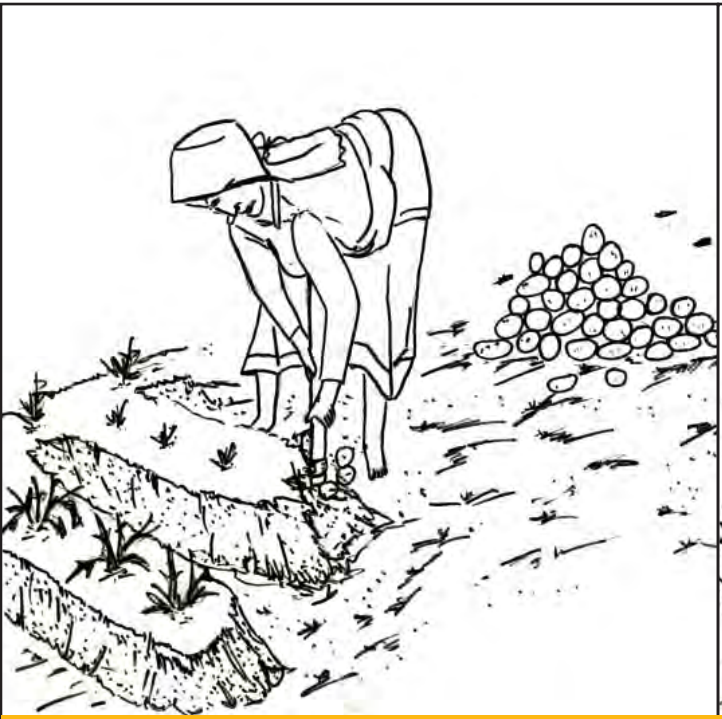
Healthy seeds

- High hilling to protect developed tubers (through closing cracks and crevices in the soil)

Preparation of high hills

Ridges are ≈ 30-40 cm high;
furrows are used as irrigation canal

- Harvest all potato at once after vegetative period is over; don't leave potato tubers in soil for longer time.



Pile up potato tubers after harvest

Covering and use of repellent plants on pile up potato tubers after harvest

- Don't leave the tubers in the field for long time after harvest because the tubers will be exposed to potato tuber moth attack especially during the night when females place their eggs on tubers that are piled in the field.

Harvest and store immediately!

Natural control

- Various antagonists of the potato tuber moth occur naturally in the field; these are predators such as ground beetles, lady bird beetles, and spiders
- Parasitic wasps' specific to the potato tuber moth has been released in Nepal but their status of establishment and distribution is not known yet.

Parasitic wasps

Predators

Sex pheromones

- Use sex pheromone capsules to monitor potato tuber moth populations in potato fields and stores, using simple home-made traps (action threshold 20 moth/trap in one night).

Selfmade pheromone trap

Pheromone capsule

The trap is filled with water plus ½ tee spoon detergent. Potato tuber moth male adults drop and die.

Biological control with granulovirus (*Phop*GV) in the field

*Phop*GV-infected larvae

Single *Phop*GV-infected larva

*Phop*GV-infected larvae in mortar and pestle

- To obtain >95% potato tuber moth mortality use 500 virus-infected larvae in 500 liter of water per hectare; however, the application of 1 virus-infected larvae in 500 liter of water per hectare is expected to kill over 50% of the first instar larvae.

Note: • Susceptibility to the virus decreases with larval age. L3 and L4 larvae are almost resistant to the virus.
• Application within two to three week before harvest is best for reducing initial tuber infestation at harvest time.
• Repeated application of low-dosages during the vegetation period are considered more efficient than a single high-dosage application for depressing potato tuber moth field populations

*Phop*GV-infected larvae crushed

Filtered and mixed with water

Spray in field

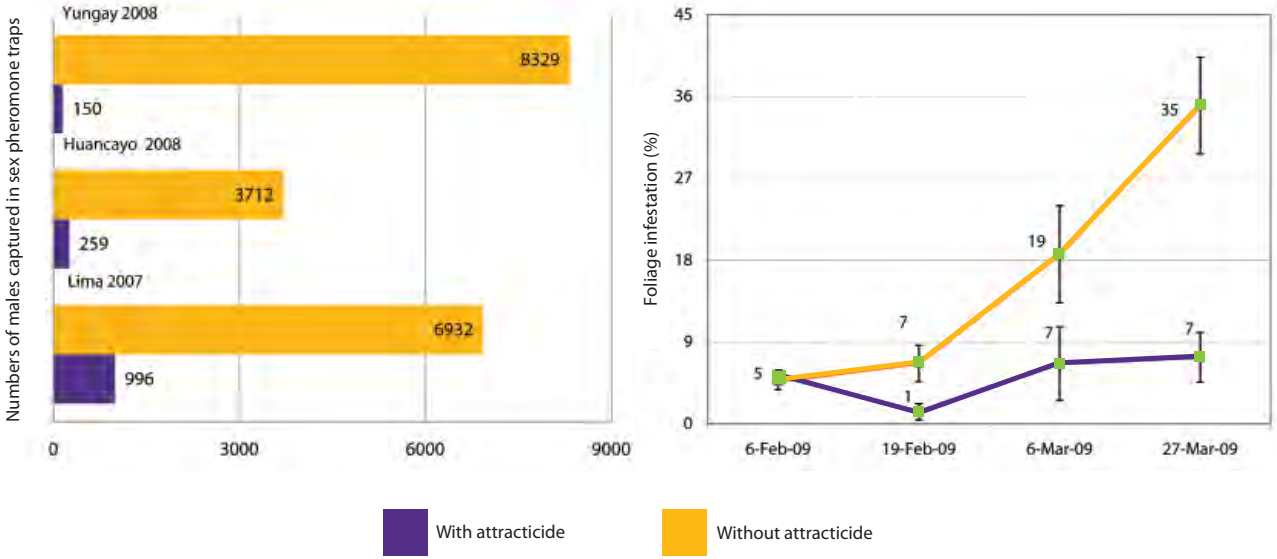
Attract-and-kill

- A co-formulation of sex pheromones with a contact insecticide.
- Application according to monitored pest numbers (>50 adults/trap/week)
- One droplet per 4 – 8 m^2

Allocation of the droplets in the field

Attract-and-kill

- Reduces the male population of the potato tuber moth and percentage infestation of potato foliage. (examples from Peru)



How to control the potato tuber moth in potato stores?

Cultural control

- Selection of healthy, undamaged tubers during harvest
- Storage hygiene; clean the storeroom; use closed stores (doors and windows closed with gauze for ventilation)
- Store healthy tubers only and destroy infested tubers (bury them or feed them to the livestock) and netting of the piled potato inside storeroom is beneficial

Cleaning of room before storing of potato

Cleaning of storage room after storage

Biological control (use of botanicals)

- *Acorus calamus* (Bojho) dust applied at the rate of 2 g/kg of potato protects potatoes against potato tuber moth attack.
- Use of repellent plants (*Artemisia* sp. (Titepati) and *Chenopodium botrys* (Bethe) chop, shade dry and use 300-330 g per 8 kg in crate). Put one layer of the plants below the tubers and another layer above the potato pile (sandwich-like) to cover whole tubers.

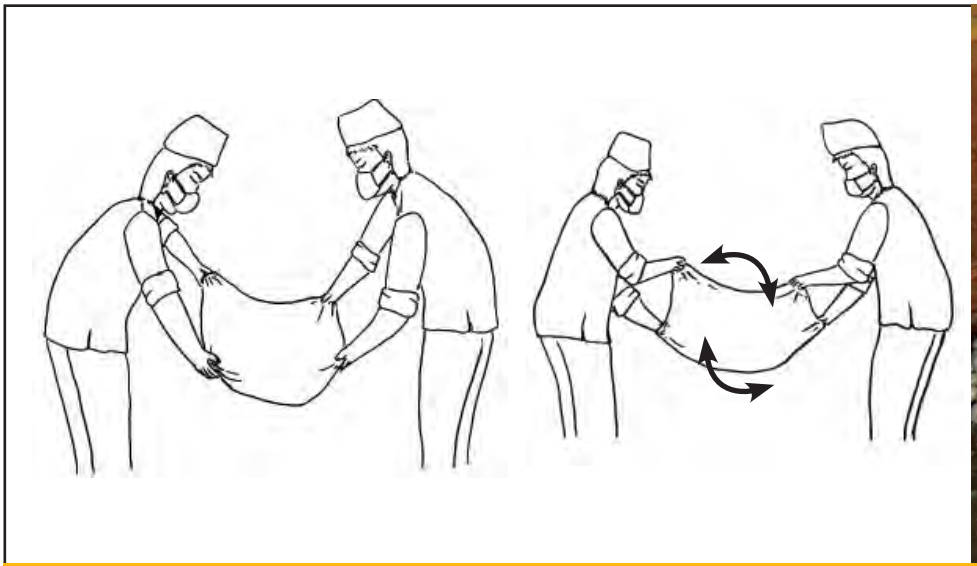
Acorus calamus dust applied to potato

Acorus calamus dust poured over a potato pile

chopped *Artemisia* applied to potato

Biological control (use of granulovirus in storage)

- Use 5 kg of product (20 granulovirus-infected larvae/kg of talcum) per ton of potato
- For convenience, place approximately 25 kg of potato in bag, add 125 g of product and shake until the powder completely covers the potato tuber
- Single application immediately after potato harvested.



Mixing of the *PhopGV* and potato tubers in sack

Mixing technique

PhopGV-treated potato

Attract-and-kill

- Apply the drops carefully on a plastic sheet/plate at a rate of one drop per qm storage space.

Use of attract-and-kill in stored potato

Management of leafminer fly

Cultural control

- Use good quality healthy seed
- Adequate fertilization
- Proper and timely irrigation
- High hilling
- Cultivation of alternate host plants in mixed cropping systems with potato or at borders (e.g. *Chenopodium sp. (Bethe), Pisum sativum (Kerau)*, Kidney beans)

Mechanical control

- Preparation and use of fixed yellow sticky traps (20 x 20 cm) at a rate of 1 trap/500 m^2 for monitoring the leafminer fly population and controlling adult leafminer flies with mobile yellow sticky traps (50-100 x 200-400 cm)

Yellow sticky trap

Yellow flex print

Bamboo sticks

Painting brush

Grease (cream color)

- By walking across potato fields, the mobile yellow sticky trap captures effectively leafminer adults above the potato foliage; the more often it is applied the more effective. It should be repeated each 5 days from 40-70 days after crop emergence. Length of the mobile trap can be variable according to the size of the potato fields (narrow terraces or flat lands).

Biological control

- Agromyzids have many natural oligophagous antagonists.

Note: The species shown below are native to South America, where they significantly suppress the leafminer fly population.
• Parasitoids prevailing in Nepal such as ***Halticoptera*** sp., ***Chrysocharis*** sp. among others, might adapt to the leafminer fly ***L. huidobrensis***.
• The conservation of natural enemies plays an important role in the sustainable management of the leafminer fly.

Halticoptera arduine

Chrysocharis flacilla

Phaedrotoma scabriventris

Chemical control

- Leafminer fly is resistant to almost all broad spectrum chemical insecticides available in the markets (Applications of Dimethoate do not have any effect on leafminer fly populations)
- It is highly susceptible to some more recent developed chemical pesticides; such as Abamectine (which attacks the larva, Larvicides).

Note: This insect quickly develops resistance to chemical pesticides; therefore these products should be used moderately only if other physical control measures fail to reduce populations sufficiently.

- Rules and regulation for the use of chemical insecticides must be followed to manage this insect.

Note: Abamectine is currently registered in Nepal only for ornamental plants.

Cultural practices and physical control

- Deep ploughing during field preparation exposes the grubs to natural enemies such as birds.
- Mixed cropping with tomato, garlic and coriander etc.
- Management of alternate hosts to reduce the adults' population.
- Use completely decomposed compost to prevent egg laying
- Collect beetles from alternate host through beating methods at night and kill them.

White grub eaten by chickens

Damage in alternate hosts

Natural/Biological control

- Entomopathogenic nematodes, e.g., *Steinernema lumjugense* (application of 2.5×10^9 IJ/ha showed good results).
- Use of entomopathogenic fungi formulated with barley/talcum (5 kg/ha), e.g., *Metarhizium anisopliae* (often appears naturally in Nepal; products are available containing 10^9 spores/g that can be used for augmentative control)
- Predators such as larvae of dipteran flies attack white grubs

Entomopathogenic nematode infected grubs

Entomopathogenic fungi infected grubs

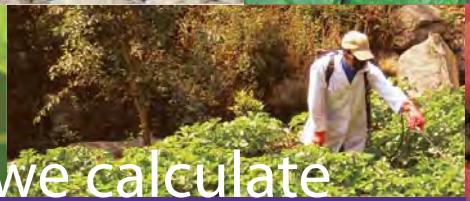
Predator: Dipteran species attacking white grub

Monitoring of potato insect pests

Insect	Trap	Observation	Damage threshold
Potato tuber moth	PTM-pheromone trap	24 hrs	20 adults per trap
Leafminer fly	Yellow sticky trap	24 hrs	5 adults per trap
Cotton boll worm	Heli-pheromone trap	24 hrs	5-6 moth per trap
Green peach aphid	Leaf observation	–	10 adults per 100 compound leaf
Green peach aphid	Yellow pan trap	1 Week	1 wing adult per trap






7

How can we calculate the potato production costs and economic benefits of the potato pest **management practices?**

Calculate the value of the potato crop, production costs, and the net benefit for the Potato production.

Example:

Field name → *Khet*

Plot Size → 2 ropani

Season → Spring

A. Labour

Activity	Family		Hired		
	man-days	NRs	man-days	NRs	Total (NRs)
-Land preparation	11	3,300	2	800	4,100
-Seeding	4	1,200	-	-	1,200
-.....	.....				
-.....					
-.....					
-.....					
Total	27	8,100	13	5,200	13,300

Note:	Family	Hired
Rate/day NRs.	300	400

B. Materials and other inputs

Activity	Amount	Unit	Price/unit		Total (NRs)
-Seeds					
- Own seeds	250	kg/---	40	NRs./kg	10,000
- Basic seeds	-	Kg/----	-		-
-Pest management					
- Pesticide A	1	kg	480	NRs./kg	480
-		---------			
-Manure & Fertilizer					
- FYM/----	60	Doko	20	NRs./Doko	1,200
- Fertilizer A	600	kg	3	NRs./kg	1,800
-.....					
-Mini tiller/Harvesting					
- Mini tiller Hire	5		350	hr/---NRs./hr	1,750
-.....		--------			
-Other inputs					
- Machinery rented	-		-		-
-.....		-------			
Total					**13,430**

C. Fixed cost calculation

Equipment	Price (NRs.)	Age	Price/year (NRs)
-Sprayer	1,300	6	200
-Power tiller	-	-	-
-…….			
-Irrigation equipments	2,000	10	200
-Cultural equipment (like Spade)	-	-	950
-……			
A. Total			1350
B. Total farm land	4	ropani	
C. Size of plot *Khet*	2	ropani	
D. Number of seasons/year	2		
E. Depreciation costs attributed to the spring crop in the plot Keth		Total NRs. for plot b =A x B/(C x D)	750 NRs.

Note: *Calculate the price per year based on deducting……..% depreciation on of fixed cost.*

D. Revenue calculation

Particulars	Amount	Area
A. Potato yield (in plot a)	3	ton 2 ropani
B. Price at harvest	12	NRs./Kg
C. Gross income (Price*Yield)	36,000	NRs.
D. Labor cost	13,300	NRs.
E. Material cost	13,430	NRs.
F. Total variable cost (D+E)	26,730	NRs.
G. Fixed cost	750	NRs.
H. Bank interest 16 %	2,850	NRs. (F + G) × H%
I. Total production cost (F+G+H)	30,280	NRs 302,800 NRs./ha
J. Net income [Gross income –Total production cost]		5,720 NRs/2 ropani

Note: *Reduce the interest rate if the money was burrow from bank for potato production.*

E. Is it worth to store potatoes for fetching a better price?

A. Marketable potatoes harvested	3		**ton**
B. Price at harvest time	12		**NRs./kg**
C. Crop value at harvest	36,000		**NRs.**
D. Total production cost	30,280		**NRs.**
E. Transport to storage	1,200		**NRs.**
F. Costs for storeroom	1,200		**NRs.**
G. Pest management costs	300		**NRs.**
H. Total storage costs (E+F+G)	2,700		**NRs.**
I. Price after storage	24		**NRs.**
J. Loss percentage	**10**		**(%)**
K. Marketable stored potatoes [A*(1-I/100)		2.7	**ton**
L. Gross income (K x I)		64,800	**NRs.**
M. Net return [L-(D+H)]		31,820	**NRs.**
N. Net return percent [L/(D+H)]		96	**%**
O. Net income increase		556	**%**

Note: ***Since costs for storing potatoes are much less then producing potatoes while the price difference for potatoes after harvest and 3 month later can be considerable the net income can be largely increase by storing potatoes if the stock can be protected against pest losses. In the example above the net return increases 5.56-times through storing potatoes instead of selling them after harvest.***

F. Partial cash flow analysis: LMF pest management

Particulars	Chemical (a)	mobile yellow trap (b)	
A. Farm size	2	2	**ropani**
B. Production cost (except pest magⁿ)	30,280		**ton**
C. Pest management	600	1,200	
-Labor	200	300	**NRs.**
-Materials			
D. Total production cost (B+C)	31,080	31,480	
E. Loss	20	10	**%**
F. Yield	3	3.27	**ton**
G. Price at harvest	12		**NRs./Kg**
H. Gross return (F x G)	36,000	39,240	**NRs.**
I. Net return (H-D)	4,920	7,760	**NRs.**
J. Net return percent (H/D)	16	25	**%**
K.Net income increase ($I_{(b)}/I_{(a)}$)		**158**	**%**

Note: *Comparing to LMF management technique, use of yellow trapping instead of current practice net income increase by 1.58 times.*

F. Partial cash flow analysis: postharvest pest management

Particulars	Chemical	Botanicals/----	
A. Marketable potatoes harvested	3		**ton**
B. Price at harvest time	12		**NRs./kg**
C. Crop value at harvest (A×B×1000)	36,000		**NRs.**
D. Production cost	30,280		
Transport to storage	1,200		**NRs.**
E. Costs for storeroom	1,200		**NRs.**
F. Pest management costs			
-chemical pesticides	300	-	**NRs.**
-other (i.e. botanicals)	-	700	**NRs**

H. Price after storage per kg	24	24	**NRs.**
I. Loss percentage (%)	10	5	
J. Marketable stored potatoes [A*(1-I/100)	2.7	2.85	**ton**
K. Gross income (J x H)	64,800	68,400	
L. Net return (K- (D+G))	96	105	**NRs.**
J. Net return percent (H/D)	16	25	**%**
K. Net income increase ($L_{(b)}/L_{(a)}$)		110	**%**

Note: ***In this example the use of botanicals results in a 1.1-times increase net income compared to chemical control.***

This economic calculation in chapter 7 was based on the interaction with farmers from Tukucha VDC of Kavreplanchowk.







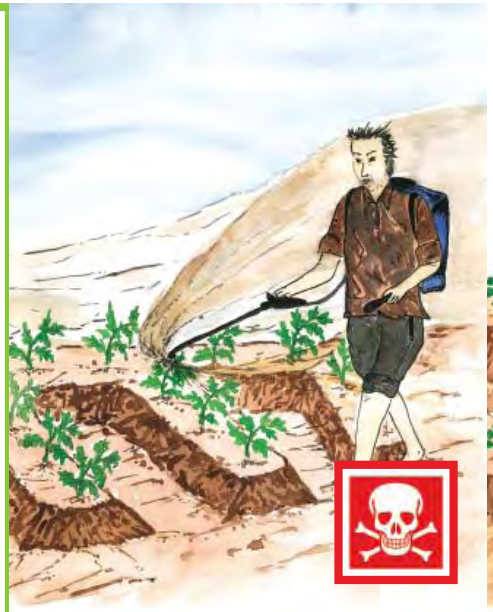
8

What do we have to be aware of when **using pesticides?**

Rational use of pesticide

- Don't use highly toxic and banned products (Ia and Ib).
- Don't mix two different insecticides.
- Only apply pesticides when required. Use the less toxic pesticide, if you have the choice.

Chlordane	Mirex
DDT	Toxaphene
Dieldrin	BHC
Endrin	Phosphamidon
Lindane	Methyl Parathion
Chlordane	Monochrotophos
Heptachlor	Endosulfan



Unsafe spraying of chemical insecticides

Safe spraying of chemical insecticides

Safety measures

- Use of proper safety measures (gloves, boots, masks, goggles, etc).

Gloves

Boots

Goggles

Aprons

- Mix the pesticide well using proper safety measures.

Unsafe mixing

Safe mixing

Safety measures

For more information contact:

Entomology Division,
Nepal Agricultural Research Institute
Nepal Agricultural Research Council
Khumaltar, Lalitpur, Nepal
Post box No. 976, Kathmandu Nepal
Telephone No. : 01-5521141, 5536224
Email: ento@narc.gov.np • ento.narc@gmail.com

Nepal Agricultural Research Council (NARC) was established in 1991 as an autonomous organization under "Nepal Agricultural Research Council Act - 1991" to conduct agricultural research in the country to uplift the economic level of the people.

www.narc.gov.np

CENTRO • INTERNACIONAL • DE LA PAPA •
CIP
A member of the CGIAR Consortium

CGIAR
Science for a food secure future

The International Potato Center (known by its Spanish acronym CIP) is a research-for-development organization with a focus on potato, sweetpotato, and Andean roots and tubers. CIP is dedicated to delivering sustainable science-based solutions to the pressing world issues of hunger, poverty, gender equity, climate change and the preservation of our Earth's fragile biodiversity and natural resources.
www.cipotato.org

CIP is a member of CGIAR.
CGIAR is a global agriculture research partnership for a food secure future. Its science is carried out by the 15 research centers who are members of the CGIAR Consortium in collaboration with hundreds of partner organizations.
www.cgiar.org