

**WELCOME**

**CROP POLLINATION AND POLLINATORS CONSERVATION**

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**Entrance Café, Lalitpur, Nepal**

# COUNTRY'S DIVERSITY FOR PLANTS & POLLINATORS



- 9 Bioclimatic zones
- 35 Forest types
- 114 Vegetation types

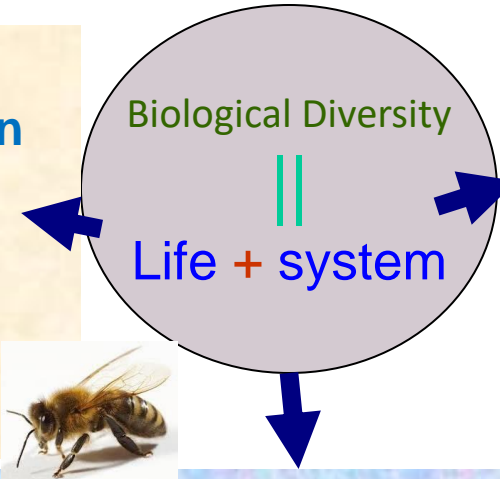
| <b>Topography<br/>Zone</b> | <b>Elevation<br/>(m)</b>                   | <b>Climate<br/>Type</b>                        |
|----------------------------|--|--|
| <b>High Himal</b>          | <b>above 5000</b>                          | <b>Tundra type</b>                             |
| <b>High Mountain</b>       | <b>4000 to 5000</b><br><b>3000 to 4000</b> | <b>Alpine</b><br><b>Sub-alpine</b>             |
| <b>Mid Hills</b>           | <b>2000 to 3000</b><br><b>1000 to 2000</b> | <b>Cool temperate</b><br><b>Warm temperate</b> |
| <b>Low lands</b>           | <b>500 to 1000</b>                         | <b>Sub tropical</b>                            |
| <b>Terai/Plain below</b>   | <b>500</b>                                 | <b>Tropical</b>                                |

# BIODIVERSITY AND SERVICES

## Sustainable foundation

### Social Security

- Cultural service: Recreation
- Cultural service: Tourism
- Cultural service: Aesthetic appreciation
- Cultural service: Spiritual experience



### Economic Security

- Provisioning food
- Provisioning raw materials
- Provisioning medicinal resources
- Provisioning fresh water

### Ecological Security

- Regulating carbon sequestration
- Regulating extreme events
- Regulating waste water treatment
- Regulating soil erosion and fertility
- Regulating local climate
- Regulating biological control
- Regulating pollination
- Regulating habitats for species
- Regulating habitats for genetic diversity



# PLANTS AND POLLINATORS

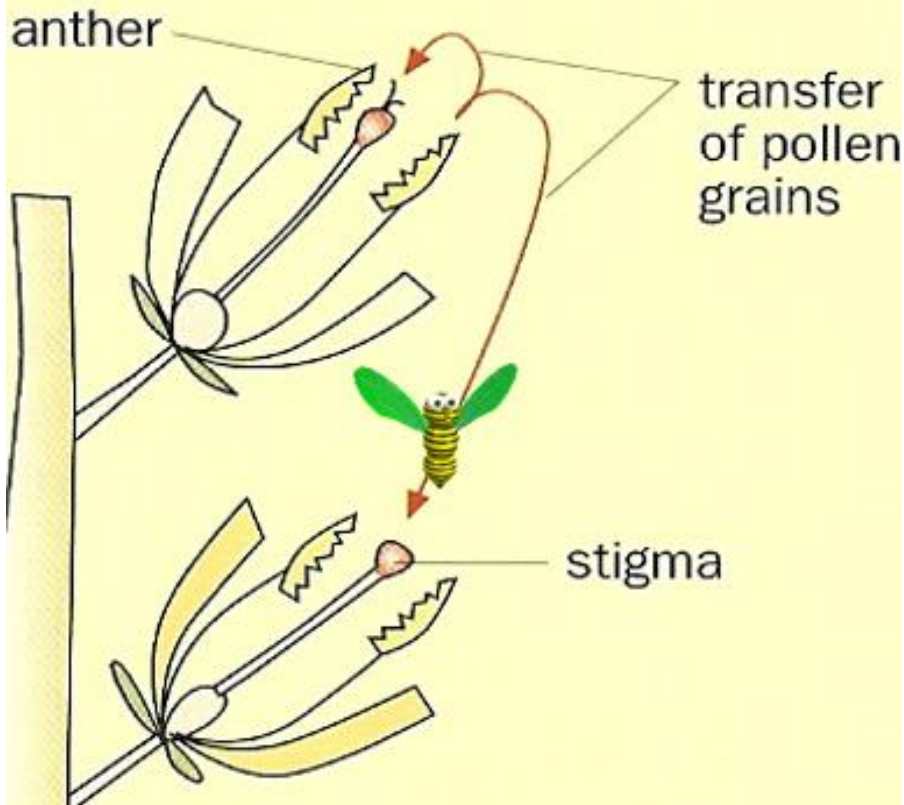
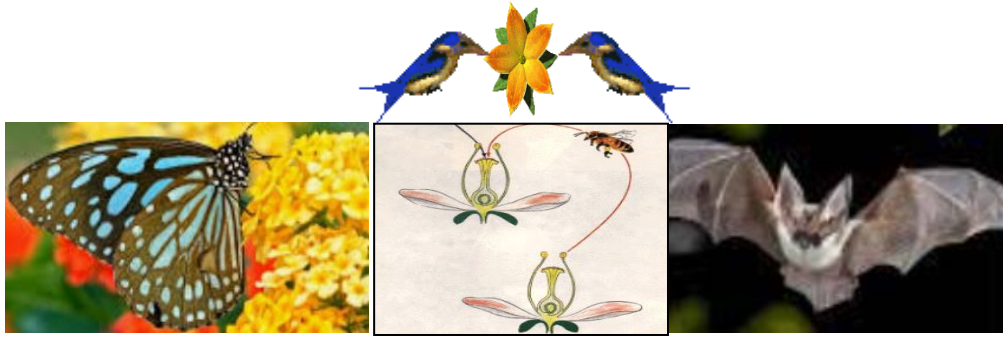
- 250,000 plant species
- 3000 tried as food crops
- 300 grown for food
- 100 species used on large scale for food
- 15 to 20 species provide 90% food needs



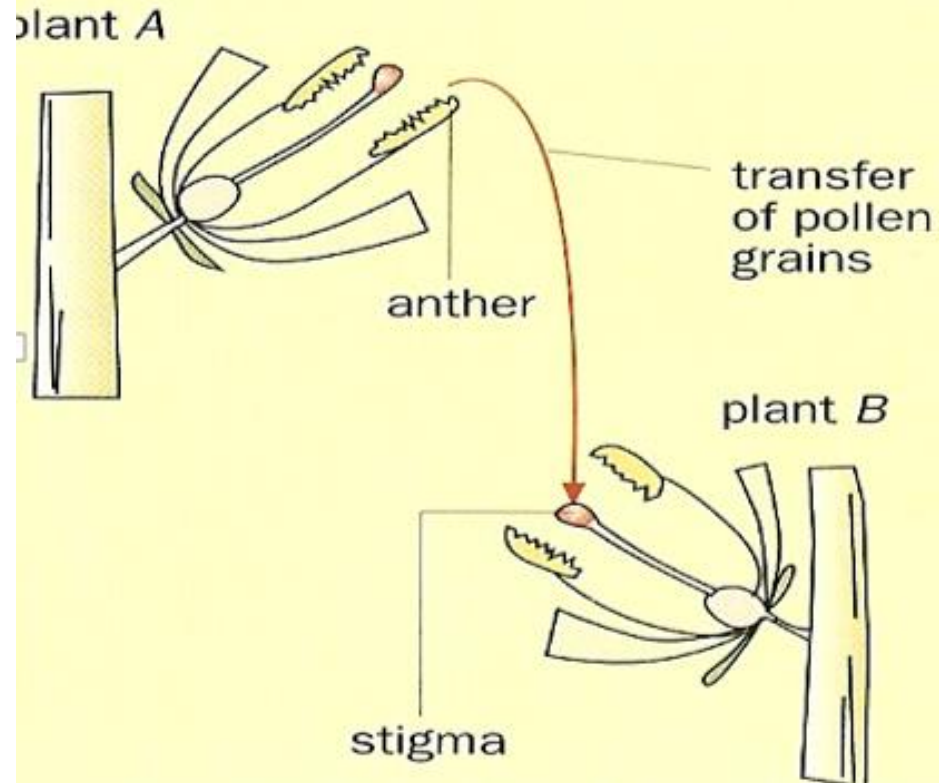
**Without Pollination they will be out of menu**

# POLLINATION

Transfer of pollen to stigma



**Self-pollination** <15% plants



**Cross-pollination** >85% plants

# POLLINATION AND POLLINATOR

- **Pollination:** Effective and cheap method of increasing crop yield and quality of crop products (Ollerton *et al.*, 2011; Rader *et al.*, 2011), uniform ripening, plant vigor (McGregor, 1976; Free, 1993), and for flower tripping to produce viable seeds (Stoddard and Bond, 1987).
- **Pollinating agents** are wind, vertebrates, and invertebrates. Nearly, half of the value of pollination services to crops comes from wild bees, as opposed to managed species (Kleijn *et al.*, 2015).
- There is **treat to pollinators** due to land use change, intensive agriculture, harmful pesticide use, GM crop, climate change, invasive species, pathogens and pests (Potts *et al.*, 2016).

# POLLINATORS DIVERSITY

- **Birds** (Species in Nepal: 856+ )

- Pollinating birds

- **Insects**

(Species in Nepal: 10000+)

- Bees
- Flies
- Beetles
- Butterflies (640+)
- Moths (2253)
- Wasps

- **Mammals**

(Species in Nepal: 181+)



Nepal is rich in bee diversity (Verma, 1992; Thapa, 2012; Kafle, 2012; Aryal *et al.*, 2015; Bista and Lakhey, 2017)

# BEST POLLINATORS

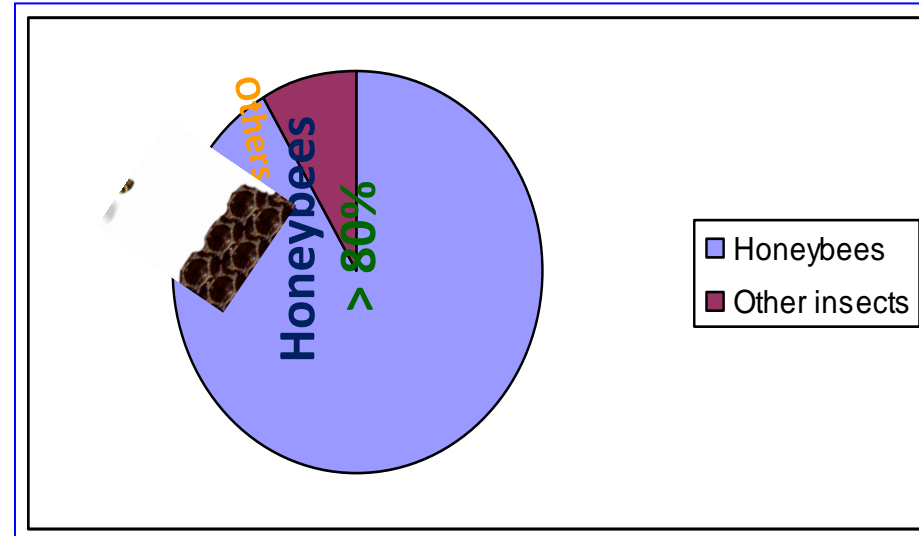
- 20,000 to 40,000 species of bees

## Honeybees species in Nepal

- *Apis cerana*
  - *Apis dorsata*
  - *Apis florea*
  - *Apis laboriosa*
  - *Apis mellifera* (Introduced)
  - *Melipona* spp. (Stingless honeybees)
- Honeybees the best pollinator among insects.

*Of the 100 crop species that provide most (90%) of the world's food, over 70 are pollinated by bees.*

*Honeybees are the most important pollinators of agricultural crops  
(Klein et al., 2007)*





## INSECT FLOWER VISITORS

|    | Crop      | Scientific name                                | Flower visitor<br>No |
|----|-----------|--|----------------------|
| 1  | Broccoli  | <i>Brassica oleracea</i> L. var <i>italica</i> | 16                   |
| 2  | Buckwheat | <i>Fagopyrum esculentum</i> Moench             | 21                   |
| 3  | Citrus    | <i>Citrus</i> spp.                             | 10                   |
| 4  | Cowpea    | <i>Vigna unguiculata</i> (L.) Walp.            | 17                   |
| 5  | Cucumber  | <i>Cucumis sativus</i> L.                      | 14                   |
| 6  | Litchi    | <i>Litchi sinensis</i> Sonner.                 | 21                   |
| 7  | Mango     | <i>Mangifera indica</i> L.                     | 11                   |
| 8  | Okra      | <i>Abelmoschus esculentus</i> Moench           | 13                   |
| 9  | Radish    | <i>Raphanus sativus</i> L.                     | 16                   |
| 10 | Rapeseed  | <i>Brassica campestris</i> L. var <i>toria</i> | 20                   |

**Source:** Thapa, 2006

## CROP FLOWER VISITORS

**Buckwheat:** European honeybee (*Apis mellifera* Lin.), Asiatic honeybee (*Apis cerana* Fab.), Rock bee (*Apis dorsata* Fab.), Little bee (*Apis cerana* Fab.), Syrphid fly (*Syrphus* sp.), Tabanid fly (*Tabanus* spp), Marsh fly (*Bibilio* sp.), Rice skipper (*Pelopidas mathias* (F.)), Lady beetle (*Coccinella* spp.), Carpenter bee (*Xylocopa* sp.), Legume pod bug (*Riptorus linalis* Fab.), Mud wasp (*Chlorion* sp.), Cabbage butterfly (*Pieris brassicae* Lin., *P. canidia* Lin.), Legume pod borer (*Lampides boeticus* Lin.), Castor butterfly (*Ergolis merione* Cram.), Housefly (*Musca* sp), Oriental wasp (*Vespa orientalis* (Lin.)), Yellow banded wasp (*Sphex* sp.), Ichneumonid wasp (*Ichneumonus* sp.), Green bug (*Nezara viridula* Lin.), Yellow butterfly (*Therias* sp.)

**Litchi:** European honeybee (*Apis mellifera* Lin.), Asiatic honeybee (*Apis cerana* Fab.), Rock bee (*Apis dorsata* Fab.), Pollen beetle (*Chiloloba acuta*), Lady beetle (*Coccinella* spp), Damsel fly (*Agriochemis* spp), Housefly (*Musca domestica* Lin.), Tachinid fly (*Agryrophylax nigrotibialis* (Baranov), Rice ear head bug (*Leptocorisa acuta* (F.)), Syrphid fly (*Eristalis* sp.), Tabanid fly (*Tabanus* spp), Peacock pansy butterfly (*Presis* sp.), Lemon butterfly (*Papilio machon* Lin.), Cowpea borer (*Lampides boeticus* L.), Cyntomid fly (*Cyntomis passalis* (F.)), Oriental wasp (*Vespa orientalis* (Lin.)), Golden wasp (*Vespa magnifica* (Smith)), Yellow banded wasp (*Sphex* sp.), Castor butterfly (*Ergolis merione* Cram.), Monarch butterfly (*Danaus plexpus* Lin.), Crane fly

# CROPS AND POLLINATORS

| SN | Crop                | Scientific Name                              | Family        | Major                 | Other Pollinators                   |
|----|---------------------|--|---------------|-----------------------|-------------------------------------|
| 1  | Kiwifruit           | <i>Actinidia deliciosa</i><br>(A. Chevalier) | Actinidiaceae | Honeybees             | > 150 insect spp,<br>spiders, mites |
| 2  | Onion               | <i>Allium cepa</i> L.                        | Alliaceae     | Honeybees             | 267 insect spp                      |
| 3  | Cashew nut          | <i>Anacardium</i><br><i>occidentale</i> L.   | Anacardiaceae | Honeybees             | Bees, flies,<br>butterflies         |
| 4  | Mango               | <i>Magnifera indica</i><br>L.                | Anacardiaceae | Honeybees             | 80 insect spp                       |
| 5  | Custard<br>apple    | <i>Abbona squamosa</i><br>L.                 | Annonaceae    |                       | 2 Beetles & black<br>ants           |
| 6  | Natal plum          | <i>Carissa</i><br><i>grandiflora</i> A.DC.   | Apocynaceae   |                       | Some insects visit<br>flowers       |
| 7  | American<br>ginseng | <i>Panax</i><br><i>quinquefolius</i> L.      | Araliaceae    | Halictid<br>bees      |                                     |
| 8  | Silk cotton         | <i>Ceiba pentandra</i><br>Gaertn.            | Bombaceae     |                       | Bats and insects                    |
| 9  | Pineapple           | <i>Ananas sativus</i><br>Schult. f.          | Bromeliaceae  |                       | Humming birds                       |
| 10 | Papaya              | <i>Carica papaya</i> L.                      | Caricaceae    | Skipper,<br>hawk moth | 17 insect species                   |

# PLANT AND POLLINATORS RELATIONSHIPS

**Custard apple: Beetle and black ants visit flowers**

**Silk cotton : Bats visit flowers**

**Pineapple : Humming birds visit flowers**

**Lettuce: Wild bees and hoverflies visit flowers**

**Cowpea : Bees, ants and flies visit flowers**

**Breadfruit: Stingless bees visit flowers**

**Cocoa: Ants, thrips, aphids midges visit flower**

**Coconut: Earwig, wasp and ants visit flowers**

**Pepper: Springtails visit flowers**

*(Free, 1993; Atwal, 1970; Mishra, 1995; Roubik, 1995; Verma, 1992)*

## **PLANT FLOWER VISITORS/POLLINATORS DIVERSITY**

***Over 300 species of insects recorded as pollinators in China and 85% plants estimated to be insect-pollinated, 5% to be self-pollinated and 10% to be wind-pollinated (You, 1997).***

**Onion:** 267 species of insects visit flowers

**Kiwi fruit :** 150 species of insects visit flowers

**Sugarbeet:** 129 species of insects visit flowers

**Toria:** 117 species of insects visit flowers

**Straberry:** 108 species of insects visit flowers

**Alfalfa:** 75 species of insects visit flowers

**Sweet vetch:** 54 species of insects visit flowers

**Cotton:** 41 species of insects visit flowers

*(Free, 1993; Atwal, 1970; Mishra, 1995; Roubik, 1995; Verma, 1992)*

# POLLINATION DEPENDENCY & VALUE

## Fruits

| Crops      | Pollination dependence (%) | Annual value (million/annum) |
|------------|----------------------------|------------------------------|
| Apple      | 100                        | \$ 1,502.60                  |
| Almond     | 100                        | \$ 959.20                    |
| Cranberry  | 100                        | \$ 294.90                    |
| Avocado    | 100                        | \$ 254.60                    |
| Blueberry  | 100                        | \$ 151.30                    |
| Cherry     | 90                         | \$ 257.22                    |
| Grapefruit | 80                         | \$ 237.92                    |
| Peach      | 60                         | \$ 255.60                    |

By including bee-friendly plants, you can attract a diverse array of other wildlife as well.



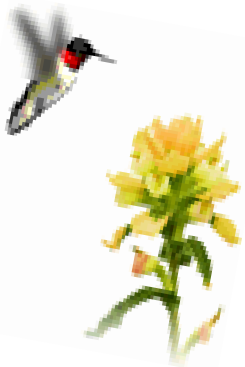
# POLLINATION DEPENDENCY & VALUE

## Vegetables

| Crops  | Pollination dependence (%) | Annual value (million/annum) |
|--------|----------------------------|------------------------------|
| Onion  | 100                        | \$ 735.30                    |
| Carrot | 100                        | \$ 467.50                    |
| Cauli  | 100                        | \$ 233.50                    |
| Squash | 90                         | \$ 2516.45                   |

## Field Crops

| Crops   | Pollination dependence (%) | Annual value (million/annum) |
|---------|----------------------------|------------------------------|
| Alfalfa | 100                        | \$ 7,756.90                  |
| Soybean | 10                         | \$ 1,649.07                  |
| Cotton  | 20                         | \$ 1,072.14                  |



# CROPS POLLINATED BY POLLINATORS



**Crops  
Pollinated by  
Honey Bees**

Macadamia

Canola  
OIL



# FLOWER VISITOR/POLLINATORS HABITAT & IMPORTANCE

Pan trap collected insects at 50% **mustard bloom** away from natural habitat in Chitwan

| <b>Family</b>      | <b>Common name</b>                | <b>600m</b> | <b>1500m</b> | <b>2800m</b> |
|--------------------|-----------------------------------|-------------|--------------|--------------|
| <b>Hymenoptera</b> | <b>Honeybees &amp; other bees</b> | <b>455</b>  | <b>290</b>   | <b>190</b>   |
| <b>Coleoptera</b>  | <b>RBT and other beetle</b>       | <b>15</b>   | <b>7</b>     | <b>11</b>    |
| <b>Lepidoptera</b> | <i>Pieris brassicae</i>           | <b>26</b>   | <b>5</b>     | <b>7</b>     |
| <b>Diptera</b>     | <b>Housefly</b>                   | <b>35</b>   | <b>29</b>    | <b>18</b>    |

**“Human reliance on arthropods as pollinator of fruit and seed crops estimated worth of US\$ 117x 10<sup>9</sup> per year world wide”**  
(Costanza et al., 1997).

**“Economic value of insect pollination worldwide estimated at 153 billion euros in 2005 and pollinator’s disappearance would cause loss between €190 to €310 billion”**  
(FOCUS:News, 2009).

# BIODIVERSITY AND ECOLOGICAL VALUE

| Particular            | Example             | Biodiversity value |
|-----------------------|---------------------|--------------------|
| Wild area             | National parks      | High               |
| Extensively used area | Extractive reserves | Medium             |
| Intensively used area | Agriculture         | Low                |
| Degraded land         | Saline, eroded land | Very low           |

## Crop pollination and yield increase

| SN | Crops                            | Control | Open | Bee Pollination  |                     |
|----|----------------------------------|---------|------|------------------|---------------------|
|    |                                  |         |      | <i>A. cerana</i> | <i>A. mellifera</i> |
| 1  | Broccoli seed (kg/ha)            | 13      | 333  | 418              | 426                 |
| 2  | Rapeseed seed (kg/ha)            | 68      | 623  | 1081             | 845                 |
| 3  | Buckwheat seed (kg/ha)           | 50      | 361  | 582              | 481                 |
| 4  | Red leaf mustard seed (gm/plant) | 60      | 109  | 146              | -                   |

Source: Thapa (2002), Dhakal (2003), Devkota (2000)

Until 1980s: 75% bees managed  
for honey production



After 1980: 75% Bees managed  
for crop pollination

# PLANT FLORA AND POLLINATORS ROLE

Nepal is rich in pollinators flora which have been recorded from **Dolakha** (Bista and Shivakoti, 2000; Neupane *et al.*, 2001), **Sarlahi** (ED, 1996), **Bara** (Panthi, 2013), different parts of **Chitwan** (Thapa and Dangol, 1990; ED, 1996; Devkota, 2003; DADO, 2004; DADO, 2005; Thapa and Pokhrel, 2007; Rijal *et al.*, 2018), **Kathmandu** valley (Kafle, 1984; Maskey, 1992), **Kaski** (Adhikari and Ranabhat, 2011), **Jumla** (Pratap and Verma, 1996; Pechhacker *et al.*, 2001), **Mahakali** zone (Bista, 1997) and **Dadeldhura** district (Joshi, 1998; Pechhacker *et al.*, 2001), **Hindu-Kush** Himalayan region (Pratap, 1997). Gautam (1984), Pratap (1992), Kafle (1992).

*About 84% of plants & 76% of food production in Europe depends on pollination done by bees*

*The cost of replacing bee pollination with hand pollination is greater than the total market value of the crops (at over £1.8 billion per year, Univ Reading, 2012)*

*Bee Flora: Plant species in HKH: Partap (1997) identified over 237 bee (and other insects) flora of the HKH. Some are:*

- Agricultural Crops (34)*
- Horticultural Crops (28)*
- Forage Legumes (11)*
- Ornamental/Avenue Trees (35)*
- Wild Plants and Forest Trees (127)*

# POLLINATORS CONTRIBUTION THROUGH POLLINATION

- The annual **contribution of pollinators** to the global economy is estimated at US\$ 235–577 billion (Potts *et al.*, 2016).
- **Pollinator dependent crops** provide many essential nutrients required for a balanced human diet (Eilers *et al.*, 2011), boost increasing in production globally (Aizen *et al.*, 2008) and fetch good price (Lautenbach *et al.*, 2012).
- An average of **63% loss of fruit** or **seed production** even if vertebrate pollinators are excluded from the flowering plants they visit (Ratto *et al.*, 2018).
- A **new challenges** appear after transformation of subsistence systems to commercial agriculture i.e. failure due to inadequate pollination, resulting challenges for improving and maintaining productivity and quality of crops (Abrol, 2011; 2019).

# IMPACT OF POLLINATOR LOSS ON FOOD AVAILABILITY

| Crops                  | Pollinator conservation  | Pollinator Loss |
|------------------------|--------------------------|-----------------|
|                        | <b>Food Security (%)</b> |                 |
| <b>Stimulant crops</b> | <b>18</b>                | <b>-24</b>      |
| <b>Fruits</b>          | <b>12</b>                | <b>-12</b>      |
| <b>Vegetables</b>      | <b>19</b>                | <b>-6</b>       |



# CONSERVATION OF BEES = POLLINATION & PRODUCTION



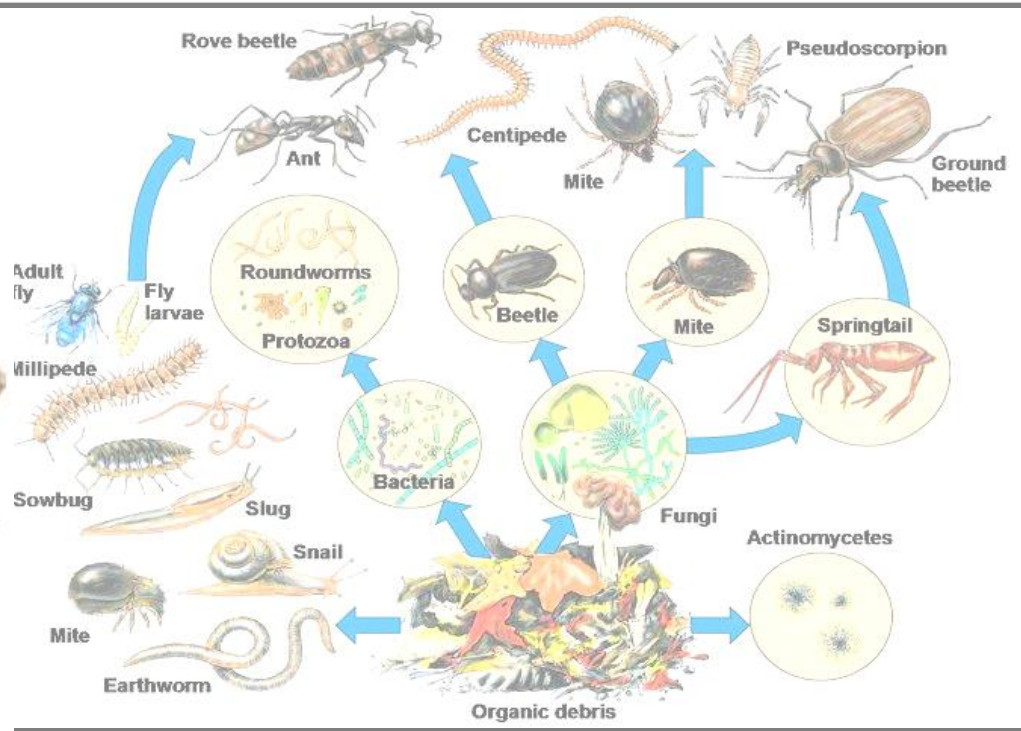
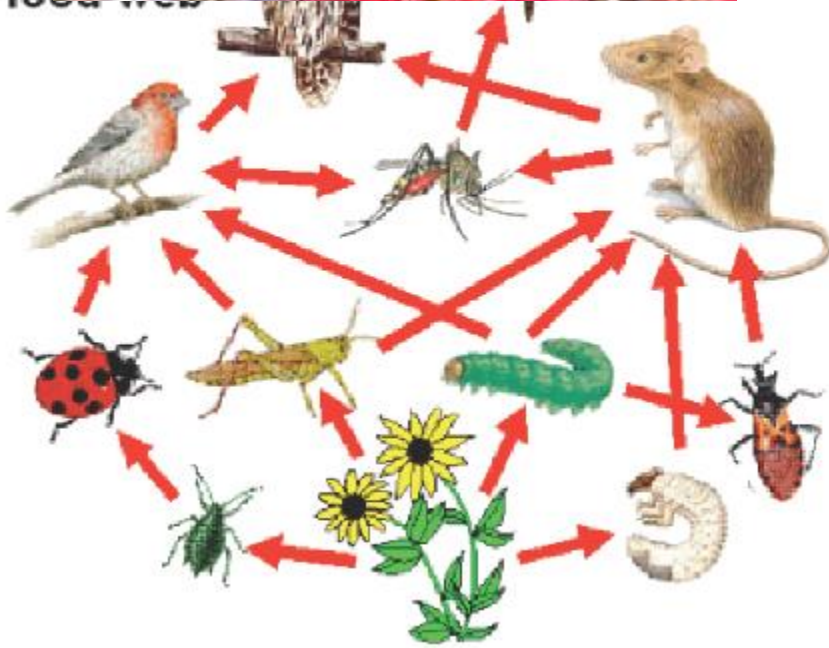
| Activity                 | J | F | M | A | M | J | J | A | S | O | N | D |
|--------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Planting                 |   |   |   |   |   |   |   |   |   |   |   |   |
| Inflorescence initiation |   |   |   |   |   |   |   |   |   |   |   |   |
| Flowering                |   |   |   |   |   |   |   |   |   |   |   |   |
| Seed setting             |   |   |   |   |   |   |   |   |   |   |   |   |
| Harvesting               |   |   |   |   |   |   |   |   |   |   |   |   |



# ECOLOGICAL STABILITY AND SUSTAINABILITY



A food web



# AWARENESS ON POLLINATION AND POLLINATORS CONSERVATION



**परागसेची जीवहरूको संरक्षण गरी ! अत्यधिक उत्पादन बढाओ !!**  
**द्विगो वातावरणीय प्रणालीको सुरक्षा गरी !!!**

परागसेचक हरि वातावरणका एक सदस्य । परागसेचक सभको भाग्यशुभता उत्पादन भएका परागको कोटी बढेमा अनुकूल हुन्छ वा अन्य पृथकको पति अनुकूल गन्तु रोक जो प्रयासबाट सम्प्रेषण र परागसेचक पृथकको हानि अनुकूल गन्तु हुन्छ, यस्तो, यस्तो, यस्तो जस्ता कारणहरूको कारणहरूको कारण । श्री विभिन्न परागसेचकको तुलना गर्दा ट.०. अन्तर्गत परागसेचक कोषहरूको रूपमा जस परागसेची कोषहरूमा सीरी, सुपरी, अन्तर्गत परागसेची ट.०. जस्ता विभिन्नको रूपमा जस वातावरणीय प्रणाली रोजी यस्ता परागसेची संरक्षण गरी जसको कारण गर्दा जो र जसको कारण परागसेचको सम्पूर्ण जीवनको कारण गर्दा ।

**परागसेचकमा फाईदाहरू:**

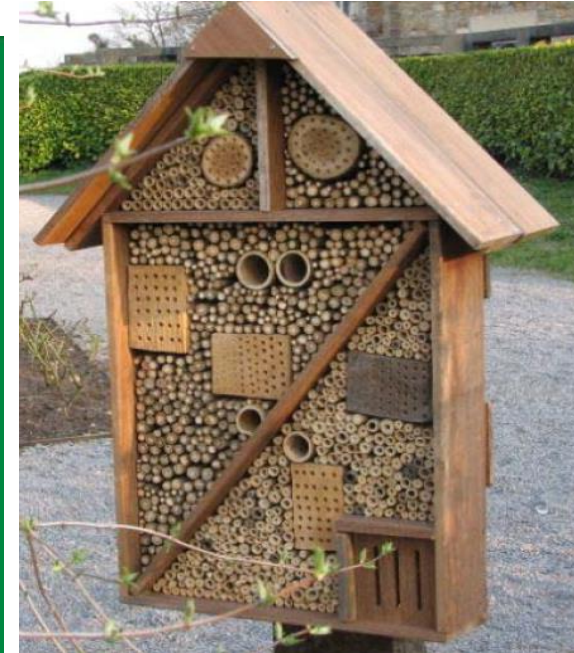
- परागसेचको बालीबालीको उत्पादन बढाउँदछ ।
- परागसेचको बालीबालीको उत्पादनको गुणस्तर बढाउँदछ ।
- परागसेचको वैश्विक विविधता बढाउन सक्ने ठोस पृथकहरू ।
- परागको अन्तर्गत, अन्तर्गत, अन्तर्गत परागसेचको रूपमा बढ्दछ ।
- द्विगो वातावरणीय प्रणालीको रूपमा बढ्दछ ।

**गौरीजन्म कोषहरूको संरक्षण किन आवश्यक छ ?**

- सीरी उत्पादनको रूपमा । अन्तर्गत परागको रूपमा परागसेचको रूपमा बढ्दछ ।
- अन्य कोषको रूपमा सीरीको रूपमा अन्तर्गत परागसेचको रूपमा बढ्दछ ।
- सीरी का कारण जस परागसेचको रूपमा अन्तर्गत परागसेचको रूपमा बढ्दछ ।
- सीरीको रूपमा अन्तर्गत परागसेचको रूपमा अन्तर्गत परागसेचको रूपमा बढ्दछ ।
- सीरीको परागसेचको रूपमा अन्तर्गत परागसेचको रूपमा बढ्दछ ।

सम्बन्धी विवरणहरू

gef UNEP





# POLLINATORS CONSERVATION

- Cropping calendar of major crops and mixed/inter/relay cropping with different crops and flowering dates to match their continuous flowering for pollinators conservation.
- Growing diversified pollinator friendly crops and ornamental plants.
- Conservation of habitats of bees and other pollinators with improved landscape by managing natural and semi-natural vegetation.
- Survey/sampling/monitoring bees & pollinators of cultivated plants (agro-ecosystem) and natural forests.
- Floral and faunal studies in natural, semi-natural, intensive agro-ecosystems, agroforestry and natural forests.
- Identification, conservation, and study pollinator-plant relations and potential resource of pollinators.
- Maximizing cropping diversity and abundance of pollinators including beekeeping in agro- and natural- ecosystems.

# POLLINATORS CONSERVATION

- Natural resource management: over-grazing, cutting, hunting, slash-burn, fire, soil erosion, deforestation etc.
- Organic farming, IPM/ IDM practices to reduce pesticide problems, management of community forestry, protected area, biodiversity garden etc for honeybee and wild pollinators conservation.
- Promotion of best management practices, integration of indigenous knowledge and mass environment awareness for bees and pollinators..
- National plans and policies for conservation and sustainable use of biological diversity, i.e. honeybee and pollinator friendly, environmentally sound agro-biodiversity promotion policies.
- Pollinators and pollination awareness, education and training, course curricula in teaching/ training institutes and well trained human resource development.
- Assessing economic value of pollinators including environmental impact assessment, and policy formulation to promote pollinator friendly environment.

# POLLINATORS CONSERVATION

## Under New Federal System

### Field level

- Declaration of some pollinator friendly plant like Chiuri tree as protected flora for its conservation.
- Promotion of organic farming and agroforestry laying emphasis on pollinator friendly plantation.

### National level

- Formulation of bees and pollinators policy for their conservation and promotion in agro- and natural ecosystem.
- Assessment of economic value of pollinators including environmental impact assessment, and policy formulation to promote pollinator friendly environment.

### Market level

Establishment of Community managed collection and processing centers to compete with quality products at national and international markets.

# GROW HEALTHY, EAT HEALTHY & LIVE HEALTHY



