Webinar 3: Pathways and risk management

Climate change and pest management

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FACTS:

Climate change substantially influences:

DIRECTLY

- ✓ biology,
- ✓ ecology,
- ✓ pest occurrence, and
- ✓ distribution of plant pests (insects, pathogens, and weeds),
- ✓ pest–host plant interactions,
- ✓ activity of natural enemies.

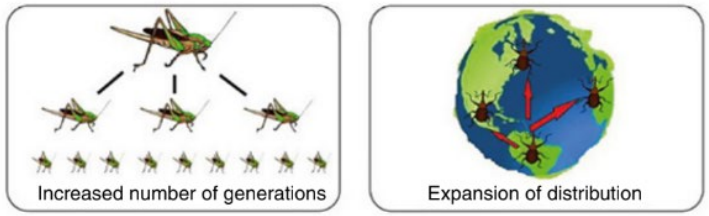
INDIRECTLY:

- ✓ efficacy of control measures applied within Integrated Pest Management (IPM) programs.
- ✓ Example: plant resistance/tolerance and biocontrol measures are highly susceptible to environmental changes.

How Rising Temperatures Affect Arthropods?

- ✓ Insects are cold-blooded organisms - temperature of their bodies is about the same as that of the surrounding environment.
- ✓ the effect of the temperature on insects' bionomy exceeds the effects of other factors

I Expansion of geographical ranges

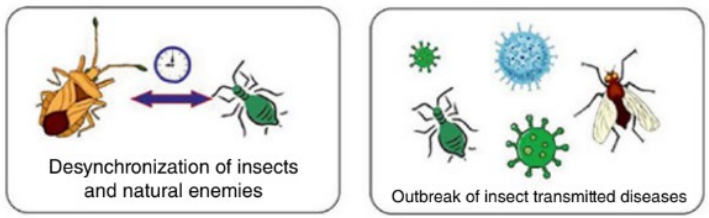


II Increase/decerease of insect populations:

III Increased overwintering

IV Impact on pest–natural enemy interactions:

V Invasive alien insect risks (IASs):



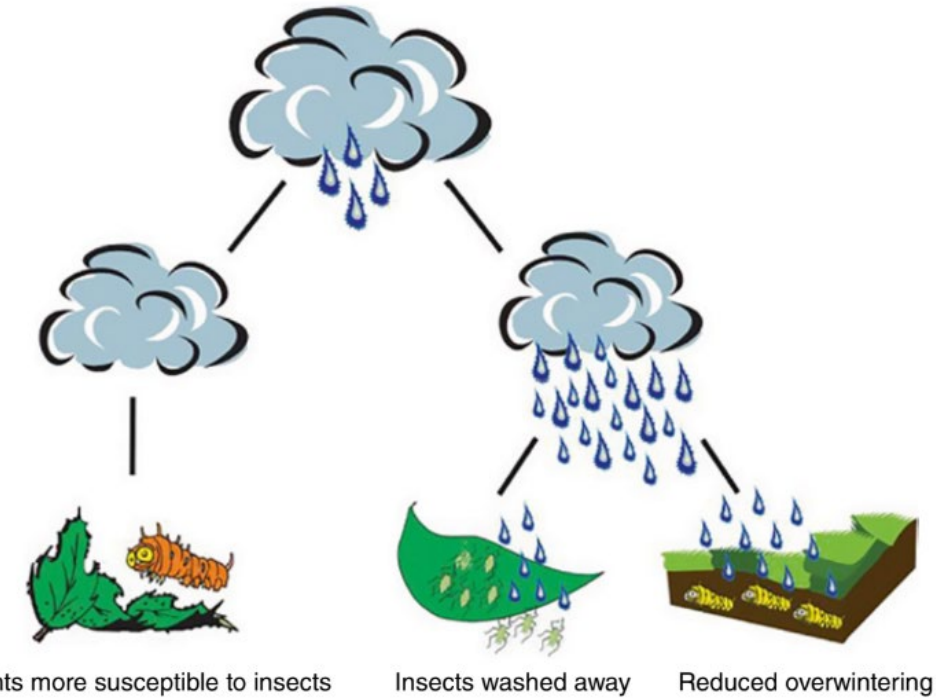
How Changes in Precipitation Affect Arthropods?

- ✓ In comparison to temperature studies, fewer scientific studies refer to it
- ✓ 3 mechanisms by which the drought affects herbivorous insect species:

(i) dry climates - suitable for the development and growth of some species;
(ii) drought-stressed plants attract specific pest species;
(iii) drought-stressed plants produce less defensive compounds of secondary metabolism - susceptible to insect attack.

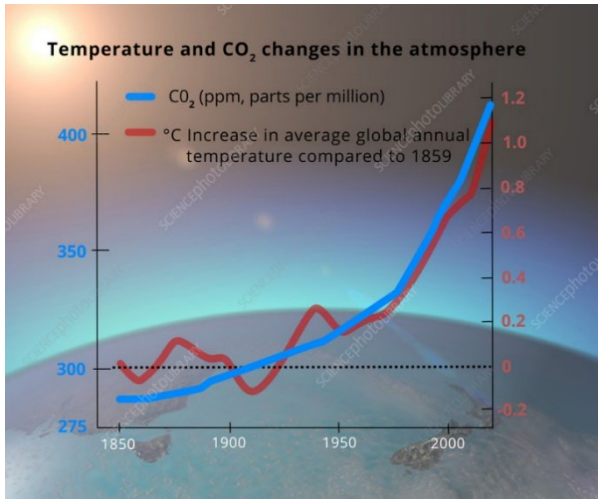
- ✓ Excess in precipitation affects small-bodied pests - can be removed from crops

- ✓ The insect species that spend winter diapause in the soil as well as soil-dwelling species are under the direct influence of rainfall (flooding and stagnation of water) - higher insect mortality



How Rising CO_2 Levels Affect Arthropods?

- ✓ The increased CO2 levels have a greater positive impact on C3 crops (wheat, rice, cotton, etc.) than on C4 crops (corn, sorghum, etc.).
- ✓ The response of insects feeding on C3 and C4 plants may differ.
- ✓ C4 crops often accumulate sugars and starches in leaves, which reduce palatability by altering the carbon/nitrogen ratio
- ✓ Insect consumption rate increases as the nitrogen content in plants increase, due to elevated CO_2, because nitrogen is the major element in insect bodies involved in body development

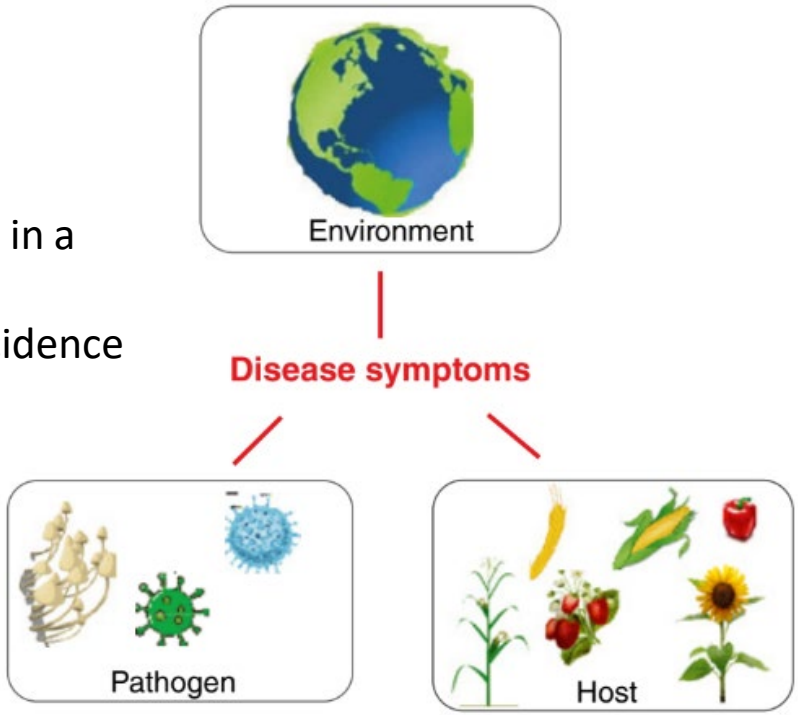


How Rising Temperatures Affect Plant Pathogens?

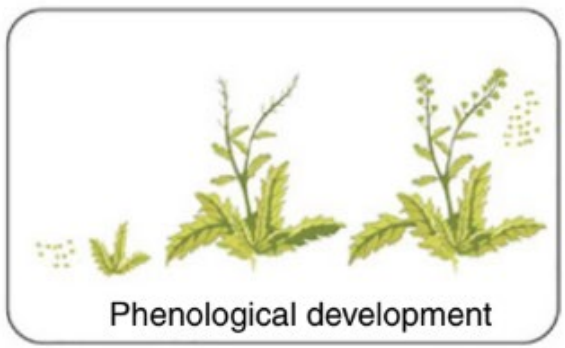
- ✓ Increased temperature, will lead to a higher incidence of some diseases,
- ✓ Better conditions for pathogen overwintering,
- ✓ Potential emergence of new pathogen strains,
- ✓ Rise of populations of pathogen vectors potentially lowering the quality of final crop/product

How Changes in Precipitation and Moisture Affect Plant Pathogens?

- ✓ A large group of pathogens requires free water available in a disease cycle.
- ✓ Disturbance in the leaf wetness - decrease in disease incidence



How Rising Temperatures Affect Weeds?



- ✓ It is **IMPOSSIBLE** to design a reliable adapted IPM program for the specific climate change scenarios on both national and/or global levels due to **DIVERSE ALTERATIONS** in all climate variables.

There is a need:

- ✓ to **EVALUATE** the efficacy of IPM techniques under diverse environmental conditions
- ✓ **ADAPT** pest management strategies to changing climate.

To address this challenge, a new approach, has been developed**: climate-smart pest management (CSPM**), which provides more focus on the management of various plant pests in the context of climate change.

General IPM principles.

1. Prevention and suppression
2. Monitoring
3. Decision making
4. Non-chemical methods
5. Pesticide selection
6. Reduced pesticide use
7. Anti-resistant strategies
8. Evaluation

Source: Adapted from Barzman et al. (2015).

Evaluation and Adaptation of IPM Practices under the Conditions of Changing Climate and 'Climate-Smart Pest Management'

IPM puts emphasis on PREVENTIVE (indirect) plant protection measures, which must be fully utilized BEFORE THE CONTROL (direct) measures are applied.

NOT A SINGLE STRATEGY brings all of the existing IPM practices and recommendations togeter with an emphasis on their adaptation to climate changes.

Therefore, there is an urgent need to:

(i) assess the efficacy of each IPM practice under different environmental conditions;
(ii) adapt the existing practices to be efficient in changing climate;
(iii) develop new IPM practices and assess the risks of their implementation
(iv) define the impact of newly developed practices on the environment, productivity, and profitability.

I Adaptation of Cultivation and IPM Practices

Adaptation of cultivation practices includes:

(i) growing climate-resilient and pest tolerant varieties;
(ii) altering planting/sowing dates to minimize the exposure to pest outbreaks
(iii) implementing agroecological techniques which increase biodiversity and the diversity of natural enemies, such as field margins or flower strips

In realtion to IPM practices several options exist:

(i) development of new pesticidal formulations;
(ii) use of biotechnical methods for biological control, mass-trapping, mating disruption, 'push–pull' strategies;
(iii) the introduction of pest-tolerant varieties;
(iv) changing the intervention thresholds for a specific pest
(v) continuous monitoring and surveillance of present and emerging pest occurrence.

II Adaptation of Economic Threasholds

- ✓ IPM programs mostly form the decisions based on the ESTABLISHED THRESHOLDS for economic yield losses, but they are not always relevant, sufficient, or possible to define.
- ✓ faster insect development at higher temperatures - population developed faster and crop damage occurred earlier than expected
- ✓ Treatment thresholds based on the number of insects per PLANT MUST BE ADAPTED and lowered in order to prevent yield losses.
- ✓ The adaptation of IPM practices and programs to CC should be based on the COMPREHENSION OF HOW THE ENVIRONMENTAL CONDITIONS INFLUENCE THE DEVELOPMENT OF CROPS AND ASSOCIATED PESTS, and their interactions with the surrounding environment.
- ✓ A drought-stressed crop is more susceptible to additional stress caused by herbivorous insects, which requires a LOWER ECONOMIC THRESHOLD for the specific pest.

III Monitoring

- ✓Monitoring pest distribution and abundance is a key component of the IPM.
- ✓One of the crucial preconditions for determining whether climate change is altering pests' population dynamics is TO ESTABLISH A LONG-TERM MONITORING (LTM) SYSTEM
- ✓LTM provides an insight into the biological responses of pests to climate change

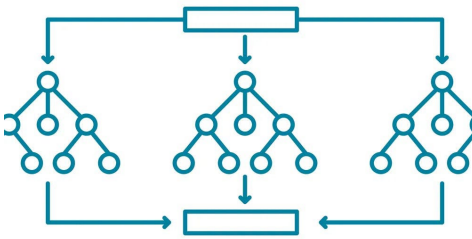
- ✓Prevents the IAS from establishing in new geographic regions and becoming of economic importance

- ✓Global information sharing system on IAS (insects, pathogens, and weeds) and current weather conditions, need to be established among regions as support to adapting IPM to the conditions of CC.

IV Climate forecasting and model development:

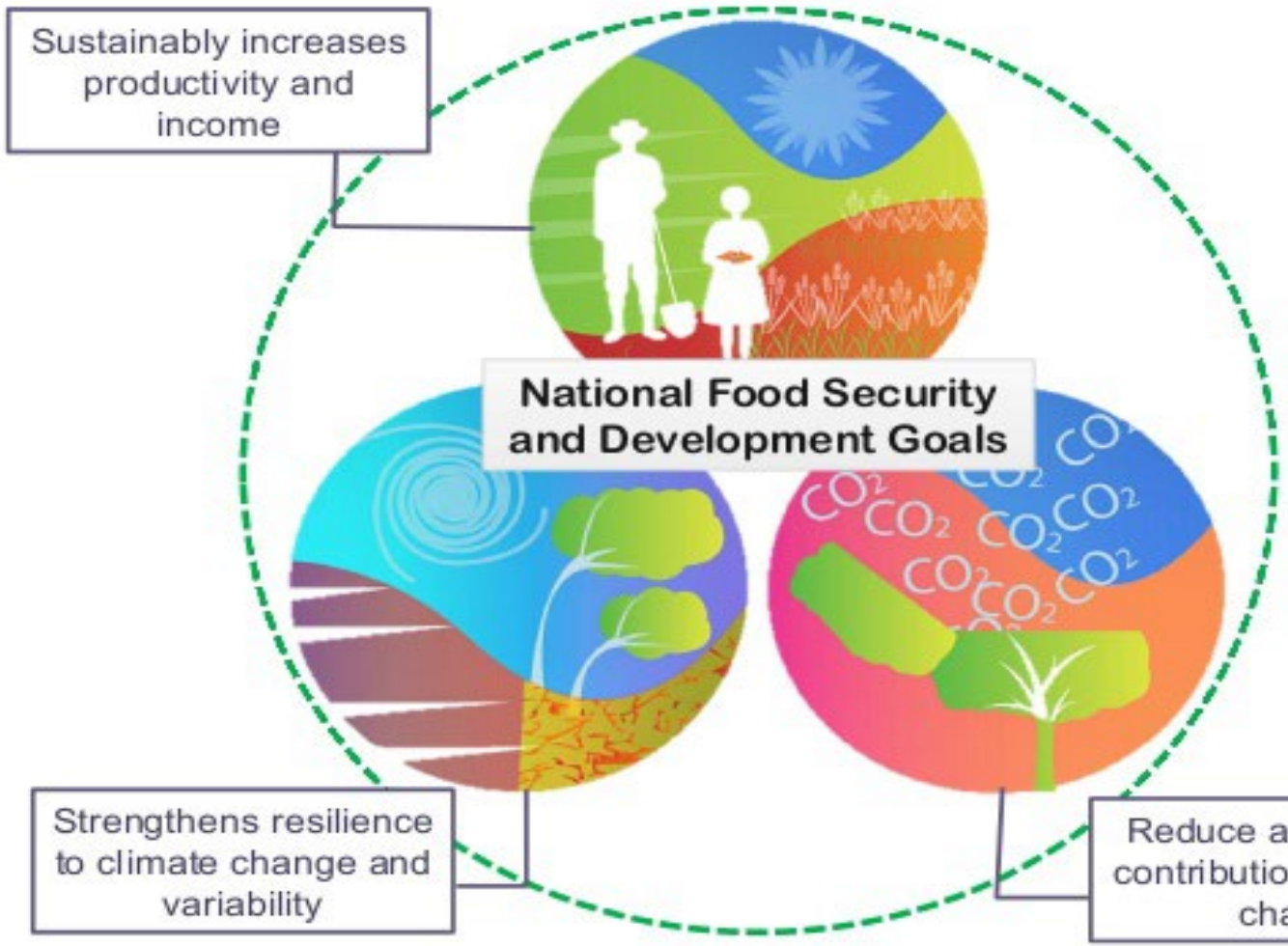
- ✓ Climate prediction models combined with the information on the environmental demands of a specific pest species can be useful in projecting the potential extent of pest risks globally.
- ✓ CORRELATIVE MODELS (MaxEnt, Bioclim, Random Forest) are mainly used for predicting the effect of climate change on pests' biodiversity, projecting changes in the geographic distribution, estimating elimination rates, and creating a road-map for biodiversity conservation sensitivity analyses.
- ✓ MECHANISTIC MODELS use environmental variables of a given area combined with information on a specific pest's tolerance to environmental factors.
- ✓ CLIMEX is an example of SEMI-MECHANISTIC MODELLING software that uses physiological and behavioural parameters of the pest and environmental (climate) variables to predict suitable habitats or regions for the specific species.

Mentioned models could be key points in developing new programs for pest prevention and control under the conditions of changing climate.

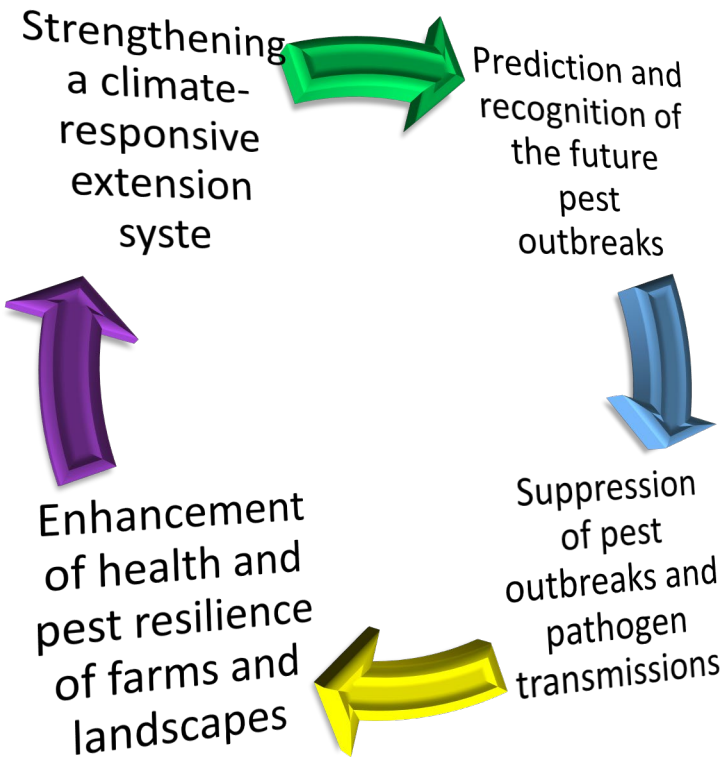


What is CSA?

CLIMATE SMART Agriculture



The most important actions of the CSPM are:



To CONCLUDE:

- ✓ The CSPM is a NEW INTERDISCIPLINARY APPROACH that involves practices that need to be adapted in primary crop production by relying on:
  - (i) extension services
  - (ii) research institutions
  - (iii) policy makers

- ✓ It strengthens the role of research, extension, and the policy makers (public and private sectors) in pest surveillance, detection, forecasting, and control

- ✓ By implementing CSPM, the crop producers, research institutions, extension services, and policy makers ACT IN COORDINATION
- ✓ In this way, the resilience of the agricultural production to climate change is enhance and overall, food security is provided

- ✓ Adaption of CSPM requires the actions of each of the above-mentioned services

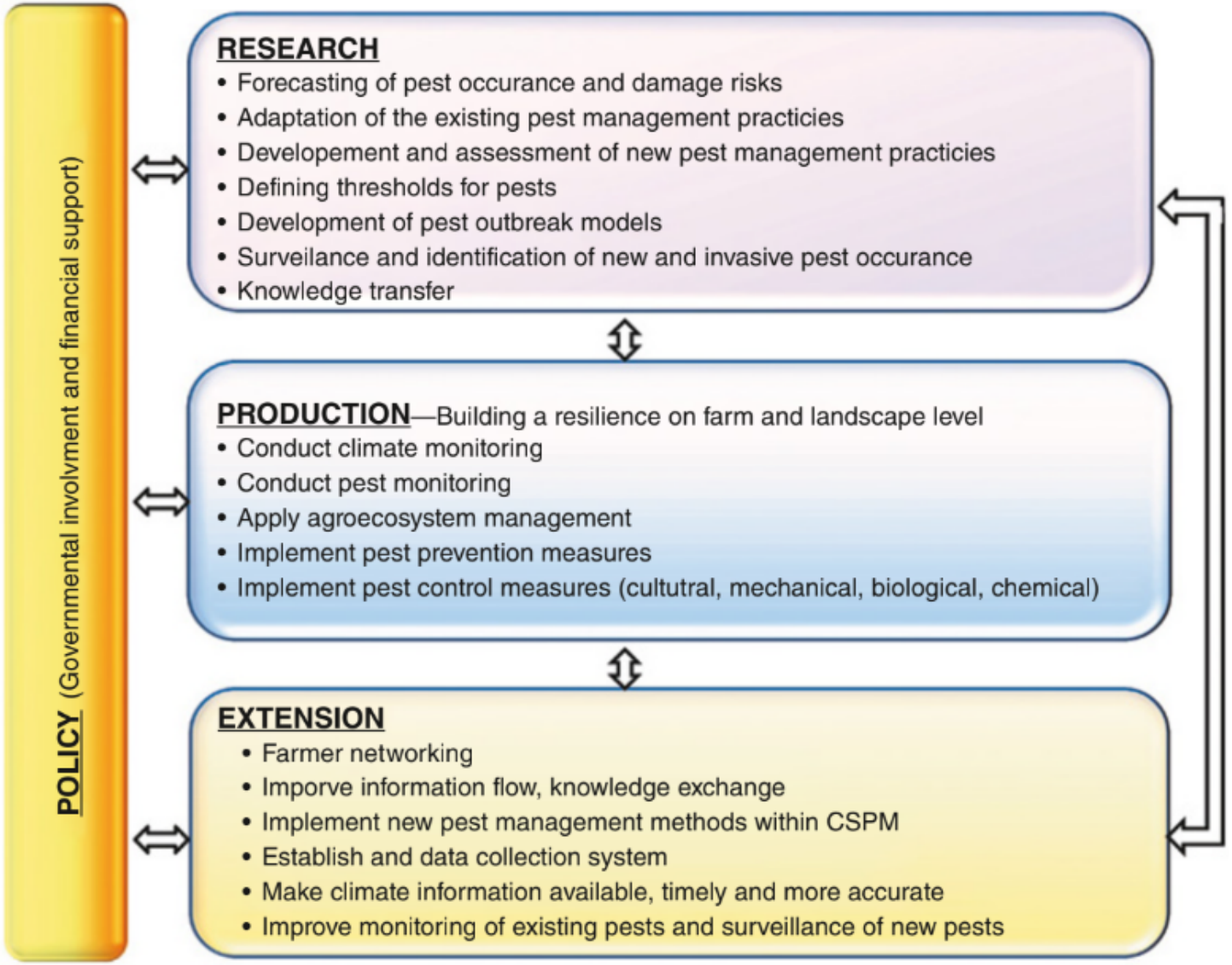


Figure 14.5 Climate smart pest management structure.

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

IPPC Webinar Series

Climate change and phytosanitary measures

Thank you for your attention