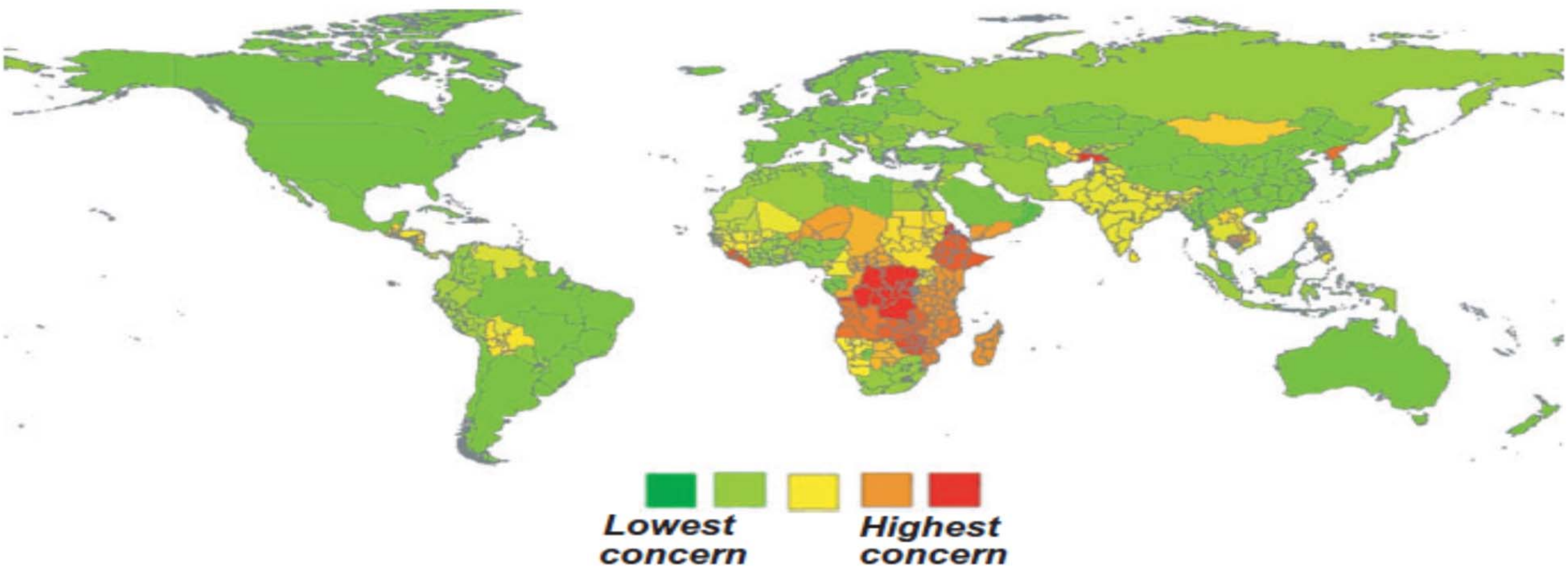
Climate change and plant diseases

- Global climate change is considered to be the chief reason for food security threats
- Climate has changed since pre-industrial times.
- Atmospheric CO_2, a major greenhouse gas, has increased by ~ 30% and temp. by 0.3-0.6 ^{0}C.
- In addition, there is a major shift in the precipitation pattern affecting crop cultivation.

Global food security concerns



Effect of global climate change on crop productivity

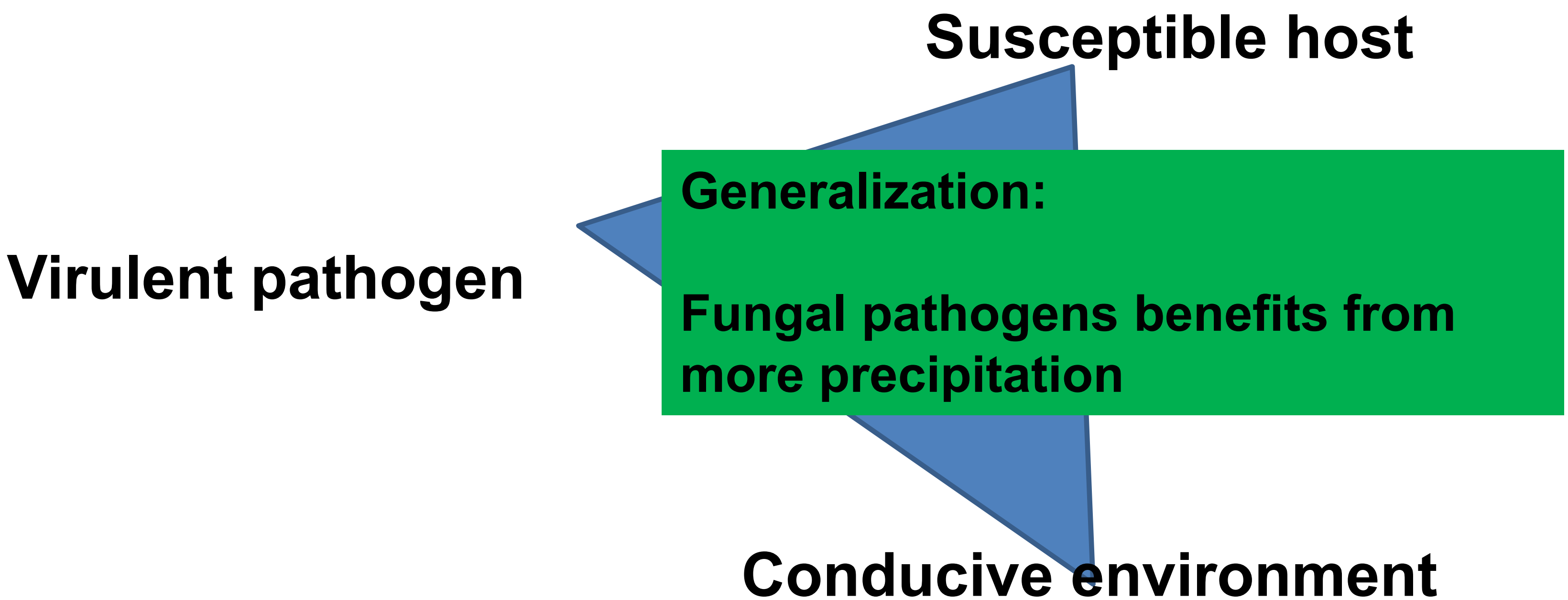
- Impact of climate change scenarios were considered and their impact on wheat, maize, rice and soybean was evaluated.
- Climatic factors considered
  - Temperature increased 2 to 4^0C
  - Precipitation varied ±20%
  - Atmospheric CO_2 concentration doubled

Impact on crop productivity

- Average crop yields at +2^{0}C warming increased by 10±15% in wheat and soybeans, and by 8% in rice and maize.
- Yields of all four crops were reduced at +4^{0}C warming indicating a threshold of compensation for the direct effect of CO_2.
- Similarly, in sorghum, yield increases due to CO_2 are masked by effects of elevated temperature resulting in an overall reduction in yield in drier regions of India

- For instance, a doubling of CO_2 has been conclusively shown to increase C3 crop yield by about 33% and C4 crop yield by about 10% in over 1000 studies.
- But the **question is** whether these benefits would still be realized in the presence of pests and diseases and other limiting factors ??

Disease triangle



- Therefore, the most likely impact of climate change will be felt in three areas:
  - in losses from plant diseases,
  - in the efficacy of disease management strategies and
  - in the geographical distribution of plant diseases.

Losses from plant diseases

Barley powdery mildew

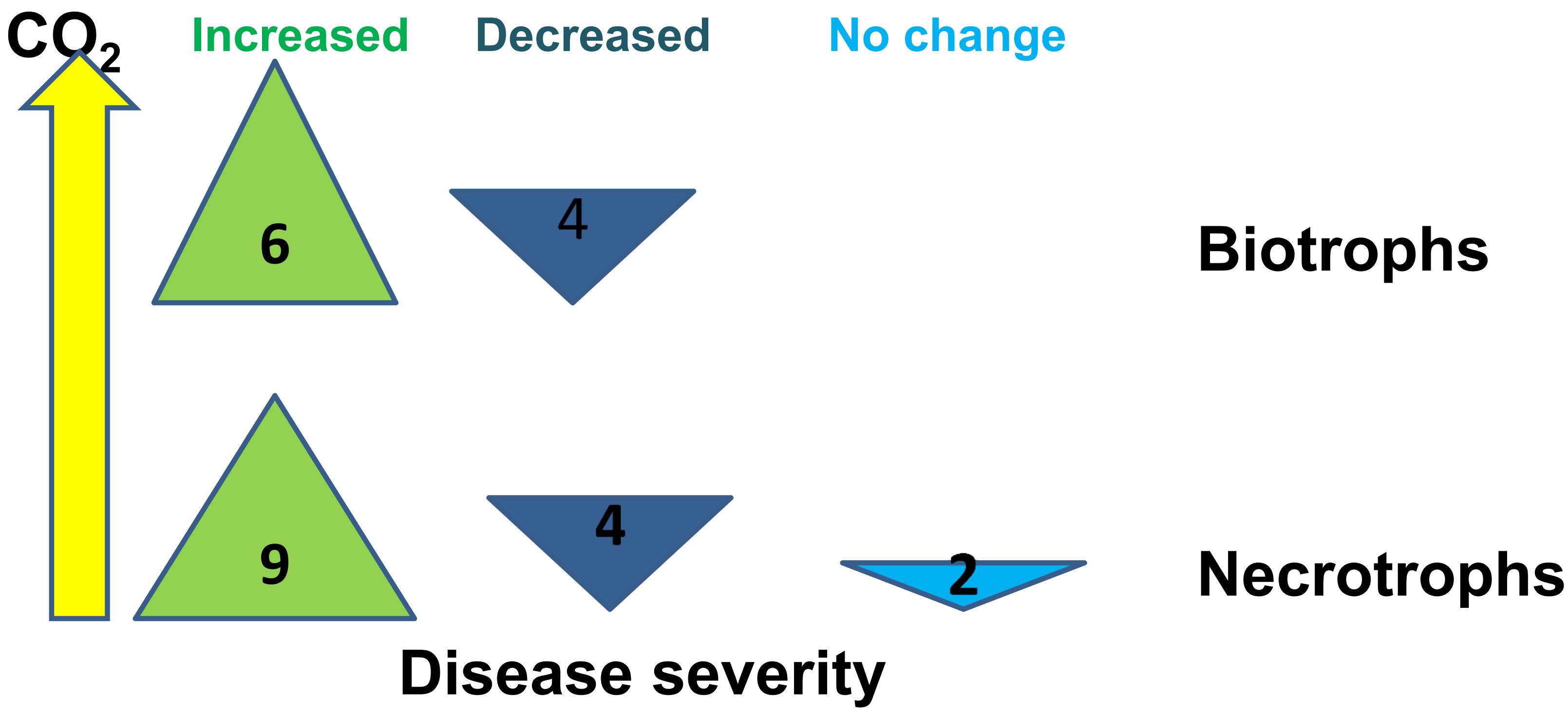
- Altered host physiology and morphology under ↑CO_2 would change the interception of light and precipitation, and modify canopy structure and microclimate to influence disease epidemiology.
- Some diseases can cause more severe reduction in plant growth under twice ambient compared to ambient CO_2.
- Example, in barley powdery mildew, photosynthesis at ↑CO_2 and infection-induced reduction in net photosynthesis caused larger reductions in plant growth than at elevated ↑CO_2

Late blight of potato

- Simulated yield loss in potato based on a 3-year long controlled environment study of late blight at ambient temperature and at 3^0C higher than ambient.
- The study suggested that increases in yield loss of unprotected potato crop at the high temperature would wipe out any benefits from yield increases of around 2 t/ha dry matter per degree of warming.

- To protect this crop from late blight, fungicide application would need to be extended by 10±20 days for each degree of warming.
- While the significance of such growth reductions on yield can not be fully determined in the absence of field studies, these results suggest that predictions of bumper harvest due to CO_2 fertilization and increased water use efficiency may be unrealistic.

Impact of CO_2 on disease severity of 10 biotrophs and 15 necrotrophs pathogens



Impact on host-pathogen interactions

- Two important trends have emerged in the effects of elevated CO_2 on host–pathogen interactions:
  - initial establishment of a pathogen may be delayed because of modifications in pathogen aggressiveness and (or) host susceptibility and
  - increased fecundity of pathogens.

Soybean rust

- The combination of increased fecundity and a more humid microclimate within dense crop canopies associated with increased CO_2 concentrations might provide more opportunities for severe infection.

Rice blast

- Risk analysis of rice blast epidemics in Asian countries caused by *Magnaporthe oryzae* showed that changes in the amount of rainfall do not affect the occurrence of the epidemics since they have little effect on the leaf wetting period.

- In cool subtropical zones, higher temperatures caused increases in disease severity because higher risk of epidemics occurs under higher temperatures.
- But in humid tropical and humid warm subtropical zones, such as Southern China, Philippines and Thailand, the opposite effect was observed. Lower temperatures increased the risk of rice blast epidemics since the current temperatures in these regions are above favorable values for the occurrence of this disease.