Annex 4. Abstracts of workshop presentations of impacts of climate change on the potential range expansion and abundance of pests in selected crops

Potato and vegetable pests

Potato tuber moth, *Phthorimaea operculella* (Zeller)

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The potato tuber moth *Phthorimaea operculella* (Lepidoptera: Gelechiidae) is considered one of the most serious pests worldwide. Potato is the main host but other Solanaceae are also attacked. It is originated in the tropical mountainous regions of South America and is reported more than 90 countries. The moth occurs in almost all tropical and subtropical potato production systems in Africa and Asia, as well as in North, Central, and South America and it's adapted to wide range of different climates and agroecologies. Losses can reach up to 40% in the field and 100% in storage. *P. operculella* attacks all vegetative plant parts of potato, typical symptoms of leaf damage are mines caused by larvae feeding in the mesophyll. Tuber infestation caused by first instar larvae can be hardly noticed and characteristic piles of feces indicate infestation. Inside tubers, larvae bore irregular galleries which may run into the interior of the tubers or remain directly under the skin in field and storage conditions. Adults are brownish gray, with fraying on the posterior edge of the forewings and on both posterior and inner edges of the hindwings. The wings are folded to form a roof-like shape with a wingspan of 12-16 mm. They are nocturnal and all activity occurs in the evening. The future distribution and abundance of this pest will be affected by climate change by changes in temperature. Using the Insect Life Insect Modeling (ILCYM) software we applied three risk indices (establishment [ERI], generation [GI] and activity [AI] index) in a geographic information system (GIS) to map and quantify changes. Under the climate of the year 2000, an ERI>0.6 represents very well the current global distribution of *P. operculella*: Africa, Oceania, South America, and Asia. Under the year 2050 temperature scenario, the boundaries for *P. operculella* are indicated to shift further north in the northern hemisphere. The number of generations indicates pest abundance and is closely related to losses. In regions where potato tuber moth is established and losses occur, a minimum of >4 generations are developed; between 12-15 generations are developed in tropical production systems. For future scenario (2050), changes in a number of generations per year of >4 will be highest in Europe and Asia. In potato production areas of Africa, Asia and South America, *P. operculella* abundance and infestation is expected to become more severe, reflected in an increase of the area with >7 generations per year. The AI indicates the potential population growth throughout a year; an increase by 1 indicates a 10-fold higher increase rate. For 2050, an increase by a factor 5-10 is predicted for most potato growing regions worldwide especially in those regions where temperatures have not reached the upper temperature threshold. For Africa, establishment of *P. operculella* will potentially increase as well as number of generations (2-5 generations/year). There are only few regions that might become too warm for potato tuber moth and more likely also for potato production. Infestations in other Solanceaea crops such as tomato might increase. The activity will generally increase; only in regions where temperature may reach values of maximum temperature threshold for development, the population growth will be gradually reduced due to increasingly high temperature-induced mortality and reduced reproduction per female. *P. operculella* is already a cosmopolitan pest but climate change will support its further spread and abundance. Phytosanitary measures and inspections are important in those countries where the pest has not yet established.

Guatemalan potato tuber moth, *Tecia solanivora* (Povolny)

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The Guatemalan potato tuber moth *Tecia solanivora* (Lepidoptera: Gelechiidae) is considered to be one of the most serious potato pests in Central and South America. It is a monophagous insect pest feeding

only on potato tubers under field and storage conditions. Losses of 100% and up to 40% are reported under storage and field conditions, respectively. Guatemala is supposedly the country of origin. It is however endemic in the whole of Central America, and has invaded Colombia, Venezuela, Ecuador and Tenerife (Canary Islands, Spain). Larvae make galleries in tubers; damage is first noticed when fully grown larvae leave tubers for pupation. The adult female is light brown and has three marks in the forewings and light brown longitudinal lines. In contrast, the male is dark brown with two marks on the first pair of wings and faint longitudinal lines. They are nocturnal. *T. solanivora* can adapt from subtropical zones in Central America at 1,000 m asl to colder zones at 3,500 m.a.s.l. The future distribution and abundance of this pest will be affected by climate change. Using the Insect Life Insect Modeling (ILCYM) software we applied three risk indices (establishment [ERI], generation [GI] and activity [AI] index) in a geographic information system (GIS) to map and quantify changes. Under the climate of the year 2000, an ERI [0.8-1] represents very well the current global distribution of *T. solanivora*: Central America, Venezuela, Colombia and Ecuador. Global predictions for 2050 indicate a reduction in the high-risk areas (ERI>0.8) in tropical areas of America, Africa and Asia, and a slight range expansion to more temperate areas. The number of generations in Central America, Venezuela, Colombia and Ecuador ranged from 3 to 10 generations per year and future scenario (2050) may potentially increase its abundance by 2 to 4 generations especially in subtropical regions. Currently, a high activity (AI) is shown (6 – 11.5) in Central America, Venezuela, Colombia and Ecuador and in the future, a marked potential population growth might occur in Mexico, south of South America, southern Europe and southern Australia. In Africa, the risks of establishment will potentially decrease in all potato-growing regions, but potato-growing regions of Angola, Rwanda and Tanzania remain at high potential risk (ERI >0.8). *T. solanivora* is an A2 quarantine pest for EPPO and its spread is not only limited by temperature but also depends on the year round presence of potato tubers. Phytosanitary measures and IPM help to control and reduce its dissemination and related yield losses.

Serpentine leafminer fly, *Liriomyza huidobrensis* (Blanchard)

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The leafminer fly, *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae) is a pest species from Central and South America, which had since the 1990s spread with plants to many parts of the world. In the tropics, subtropics and warmer parts of the temperate zone, *L. huidobrensis* has established itself in fields and has become greenhouse pest in colder climates of the northern hemisphere. *L. huidobrensis* has a wide host range. It causes direct damage to photosynthetic plant tissue due to larvae leaf mining, and damage by oviposition and feeding punctures (stipples) produced by adult females. Both crop yield and marketability are reduced, resulting in high economic losses to vegetable producers around the world. The polyphagous nature of *L. huidobrensis*, combined with high reproductive rates and rapid development of insecticide resistance, contributed to the success of *L. huidobrensis* as an invasive species. The life cycle is completed between 10 ºC (65.5 days) and 30 ºC (14.9 days), with the optimum temperature for overall population growth between 20-25 ºC. The establishment risk index (ERI), the generation index (GI), and the activity index (AI), allow to predict and explain the future distribution and damage potential of the pest under different climate change scenarios. An ERI of 0.8-1 reflects well the current global distribution of *L. huidobrensis* in the year 2000, as well as the high number of generations/year (GI>17) that develop in tropical and subtropical regions. Global predictions for 2050 indicate a potential reduction of high-risk areas (ERI>0.6) in these regions and a slight range expansion to more temperate regions, but still with a low establishment potential of the pest (ERI<0.6). Also, an increase of 2-4 generations/year can be potentially expected in Central and South America, Africa and Middle East. The AI indicates a potential increase in the potential growth of *L. huidobrensis* in Southern South America, and Southern Africa; instead increasing temperature along the Equator will potentially **reduce** *L. huidobrensis* activity. Early predictions could help adaptation to climate change by developing and supporting farmers with adequate pest management strategies to reduce greater crop yield and quality losses. Adapting to avoid risk at the farm level implies an ecological and economic control of leafminer based on integrated pest management by promoting natural regulation and combining cultural practices with physical and chemical control.