Submissions for Diagnostic Protocols

1. General information

Submission number	2021-008
Title of Proposal	Diagnostic protocol for Spodoptera frugiperda (Fall Armyworm)
Submitted by	IPPC Contracting Party New Zealand
Submission supported by	Ministry for primary industries

2. Contact information

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3. Summary of proposal

Summary of justification for the proposal	The Fall Armyworm, Spodoptera frugiperda, is a lepidopteran pest that feeds in large numbers on the leaves, stems of more than 350 plant species, causing major damage to many economically important crops e.g. cotton, maize, rice, sorghum, sugarcane, wheat. Native to the Americas, it has been repeatedly intercepted at the border of many countries, e.g. Europe, and has spread to Africa, Indian subcontinent, Bangladesh, Thailand, Myanmar, China, Sri Lanka and recently Australia. The ideal climatic conditions for fall armyworm present in many parts of Africa and Asia, and the abundance of suitable host plants suggests the pest can produce several generations in a single season, and is likely to lead to the pest becoming endemic. A diagnostic protocol would benefit many countries ensuring a consistent approach to diagnostics and combine all the essential diagnostic information such as taxonomic keys and molecular bar codes into one publication.
Proposed priority	1 (high)
Comments	Fall Armyworm is a major emerging pest and the proposed diagnostic protocol would be a benefit for many countries.

4. Literature review

Literature review	Spodoptera frugiperda, fall armyworm (FAW) a native pest of tropical and subtropical regions of the Americas was first recorded from the African continent in 2016 (Goergen et al., 2016), and the Indian subcontinent in 2018 (Ganiger et al., 2018). By 2019 it was present in 44 sub-Saharan African countries, as well as in South East Asia (CABI factsheet). In 2020 it was detected in Torres Strait, (IPPC, 2020) and on mainland Australia and in New Caledonia. (IPPC 2021). It causes major damage to more than 350 plant species including economically cultivated grasses such as maize, rice, sorghum, sugarcane, and wheat, but also other vegetable crops (CABI Datasheet). Its significant dispersal capability, high reproductive capacity and wide host range make it a pest with significant establishment potential. Therefore, early detection and the accurate identification of the species is critical in its management or eradication planning. There are taxonomic keys available to identify S. frugiperda at both late larval instar and adult life stages: A description of the larva and adult by Pogue (2002), a key to adults and/or larvae

	in the genus Spodoptera by Oliver (1981), Passoa (1991; 2008), Todd & Poole (1980), and in EPPO (2015) are useful tools. Also, there are two different genetic strains exist, the corn-strain (C-strain) feeds primarily on maize, cotton and sorghum and the rice-strain (R-strain) feeds primarily on pasture grasses and rice. The two strains occur sympatrically and are indistinguishable morphologically, though they exhibit several behavioural and genetic differences (Powell et al., 2004; Uhbehend et al., 2014; Nagoshi et al. 2018). Over 460,000 sequences in GenBank, and a real-time PCR has been developed for the identification of four Spodoptera species of quarantine importance, including S. frugiperda (Van de Vossenberg & Van Der Straten, 2014). All available above tools are scattered in different journals or databases, and there is a need for a comprehensive diagnostic protocol with a morphological and molecular protocols. This will help in fast and accurate identification of the species enabling effective management or eradication programmes. • Ganiger et. al., (2018). Occurrence of the new invasive pest, fall armyworm, Spodoptera frugiperda, in the maize fields of Karnataka, India. Current Science, 115(4): 621-623. • Goergen, et. al., (2016). First report of outbreaks of the fall armyworm Spodoptera frugiperda, a new alien invasive pest in West and Central Africa. PLoS one, 11(10): 1-9. • Nagoshi, et. al., (2012). Inferring the annual migration patterns of fall armyworm in the United States from mitochondrial haplotypes. Ecology and Evolution 2(7), 1458-1467. • IPPC, (2020 &2021). First detection of Spodoptera frugiperda in Torres Strait and New Caledonia. In: IPPC Official Pest Report, (No. AUS-96/1). Rome, Italy: FAO. IPPC - International Plant Protection Convention • CABI datasheet. Spodoptera frugiperda (fall armyworm) (cabi.org) • Oliver, A.D. (1981). Biology and illustrated key for the identification of twenty species of economically important noctuid pests. LSU Agricultural Experiment Station Reports. 260. • Passoa, S. (1991). Colour identification of economically important Spodoptera larvae in Honduras (Lepidoptera: Noctuidae). Insecta Mundi. 414. • Passoa, S. (2008). Field key to the larvae of Spodoptera of America North of Mexico. Ohio State University. • Pogue, M. G. (2002). A world revision of the genus Spodoptera Guenée. Memoirs of the American Entomological Society 43: 1-202. • Powell, et. al., (2004). Multilocus genetic analysis of host use, introgression, and speciation in host strains of fall armyworm. Annals of the Entomological Society of America, 97(5), 1034-1044. • Unbehend, at.el., (2014). Geographical variation in sexual attraction of Spodoptera frugiperda corn- and rice-strain males to pheromone lures. PLoS ONE 9(2). • Van de Vossenberg, B.T.H., & Van der Straten, M.J. (2014). Development and validation of re

5. Criteria for prioritization of Diagnostic Protocols

Criteria	Information provided by Submitter
1. Need for international harmonization of the diagnostic techniques for the pest (e.g. due to difficulties in diagnosis or disputes on methodology)	Advice as to what diagnostic techniques provide the most accurate identification for each life stage for different situations. Lack of access to quick PCR identification techniques for farmers in developing countries needs to be addressed with the next best methods and limitations explained. More accurate and compact taxonomic descriptions for diagnostic laboratories and molecular techniques to differentiate the C strain from the R strain. Genome data that would assist in determining the origin of Fall Armyworm (FAW) if an incursion occurred. Identifying insecticide resistance genes.

Criteria	Information provided by Submitter
2. The relevance of the diagnosis to the protection of plants including measures to limit the impact of the pest.	Early and accurate identification of this pest would be essential for any eradication programme or control measures. Positive identification of adults caught in pheromone traps would signal that a timely treatment can be applied prophylactically before egg laying or the presence of first instars preventing significant economic damage to the crop. It could also alert authorities that have area freedom from this pest that it is expanding its range naturally or identify pathways through trade. Early recognition of this pest on imported commodities at the border would allow treatment to mitigate the biosecurity risk.
3. Importance of the plants protected on the global level (e.g. relevant to many countries or of major importance to a few countries).	There are two different genetic strains exist, the corn-strain (C-strain) feeds primarily on maize, cotton and sorghum and the rice-strain (R-strain) feeds primarily on pasture grasses and rice.
4. Volume / importance of trade of the commodity that is subjected to the diagnostic procedures (e.g. relevant to many countries or of major importance to a few countries).	Given Spodoptera frugiperda broad host range, trading commodities that pose a risk need to be identified. Spodoptera frugiperda ability to fly long distances is a pathway that we have little control over. Studying weather patterns and optimal seasonal conditions combined with trap and host placement should assist early detection.
5. Other criteria for topics as determined by CPM that are relevant to determining priorities	Guidelines on surveillance trapping for early warning for FAW area freedom zones or countries.
6. Th balance between pests of importance in different climatic zones (temperate, tropics etc) and commodity classes.	Is the rampant expansion of this pest being assisted by climate change? The zones between sub-tropical and temperate may be marginal for now but will this pest adapt quickly to cooler zones providing host is available.
7. Number of labs undertaking the diagnosis.	Many labs would use this protocol worldwide.
8. Feasibility of production of a protocol, including availability of knowledge and expertise.	A large amount of knowledge is available on the web. But it's from various sources. It would be helpful for the reader to know the best reference for identifying various stages of this pest.