International Symposium on the Impacts of and Alternatives to Systemic Pesticides on Biodiversity and Ecosystems

Nay Pyi Taw, Myanmar, March 31, 2017

Background

Large-scale prophylactic use of systemic insecticides such as neonicotinoids is having significant, unintended ecological consequences on biodiversity, particularly on pollinators. Adverse effects have also been documented on a wide range of other non-target organisms in terrestrial, aquatic, wetland, marine and benthic habitats. But neonics and other systemic pesticides are used elsewhere in agriculture—as foliar sprays, soil drenches and seed treatments—in horticulture, turf grass production, golf courses and other applications and even in flea and tick treatments for pets. Further knowledge is needed on their effects (especially on soil and aquatic biodiversity) and on the development of alternatives, such as biological control, in Integrated Pest Management.

Systemic pesticides were identified as an emerging threat requiring urgent study by Myanmar's National Biodiversity Strategy and Action Plan (NBSAP) 2015-2020 (https://www.cbd.int/doc/world/mm/mm-nbsap-v2-en.pdf).

Task Force on Systemic Pesticides

Established in 2009 and as a joint task force of the IUCN Species Survival Commission (SSC) and the IUCN Commission on Ecosystem Management (CEM) in 2011, the Task Force on Systemic Pesticides (TFSP) (http://www.tfsp.info/) is the response of the scientific community to concern around the impact of systemic pesticides on biodiversity and ecosystems. Its intention is to provide the definitive view of science to inform more rapid and improved decision-making.

Summary

Coordinated and co-financed by IUCN, with the TFSP covering the international travel costs of its members, the *International Symposium on the Impacts of and Alternatives to Systemic Pesticides on Biodiversity and Ecosystems* was held at the Yezin Agricultural University (YAU) near Nay Pyi Taw and opened by Dr. U Aung Thu, Union Minister of Agriculture, Livestock, and Irrigation, on March 31, 2017.

After the welcome address by Prof. Dr. Myo Kywe, Rector of YAU, nine presentations were given by speakers from Australia, France, Italy, Myanmar, Malaysia, the Philippines, and Switzerland. Prof. Dr. Myo Kywe also delivered the closing remarks.

After the symposium, the TFSP Chairman and Vice-Chairman discussed next steps with Naing Kyi Win, Director of the Department of Agricultural Research. These include producing of a Myanmar version of the book *Systemic Pesticides – a Worldwide Assessment* published by De La Salle University in cooperation with the TFSP on April 4, 2017.

A farewell dinner was hosted by IUCN in the presence of H.E. U Yan Lin, Chairperson of the Agriculture, Livestock, and Rural Development Committee and Member of Parliament, and many university staff.

In addition to those mentioned above, the following participants attended the symposium:

- Aye Aye Mar, Managing Director, J-77 Agricultural Product & Trading Cooperative Ltd.
- Dr. Khin Hein Nyunt, Deputy Director, Department of Agricultural Research, YAU
- Tanako Koji, Chief Advisor, Project Office, YAU

- Dr. Shanti Lal Mehta, Resident Advisor, Indo-Myanmar Advanced Center for Agricultural Research and Education, YAU
- Dr. Ah Nge Htwe, Lecturer, Department of Entomology and Zoology, YAU
- Dr. Kin Mi Mi, Assistant Professor, Department of Entomology and Zoology, YAU
- Dr. Ohn Mar Lynn, Assistant Professor, YAU

Conclusions

Myanmar, like many other developing countries is at risk of the "systemic pesticide tsunami" from China. There is strong interest in collaborative research but local expertise is limited. One arrangement is for local researchers to carry out surveys and collect data but have samples analysed overseas.

To fill help this gap, the Chair of TFSP's Public Health Working Group, Dr. Kumiko Taira, could be invited to conduct her "short term memory" experiment in Myanmar. Basic baseline surveys on the status of pesticide marketing would also be very useful as the initial objectives would to review and revise the regulatory framework for pesticide marketing to restrict availability, usage, etc. Research on the impacts of systemic pesticides on pollination would also be helpful.

One funding possibility is the GEF. The GEF Operational Focal Point (OFP) is Mr. Hla Maung Thein, Ministry of Environmental Conservation and Forestry. The GEF-6 allocation for Myanmar is about $30 million. As a GEF Implementing Agency, IUCN could discuss a possible systemic pesticides project with the OFP. TFSP could provide technical assistance and scientific oversight.

The symposium agenda, participants, and abstracts and bios of the TFSP members who presented are attached.

International Science Symposium on the Impacts of and Alternatives to Systemic Pesticides on Biodiversity and Ecosystems

Yezin Agricultural University, Myanmar

31 March 2017

Programme

31 March 2017 Science Symposium

Time	Activity / Topic	Presenter / Facilitator
Opening session		
8:00 – 9:00	Registration	
9:00 – 9:15	Opening remarks	• H.E. Dr. Aung Thu, Minister of Agriculture, Livestock and Irrigation of the Republic of the Union of Myanmar
9:15 – 9:30	Welcome Address	• Prof. Dr. Myo Kywe Rector of Yezin Agricultural University
Photo Session & Coffee break		
SESSION A: Current knowledge on systemic pesticides use and consequences Moderator: Yezin Agricultural University		
10:00 – 10:20	**Task Force on Systemic Pesticides (TFSP) – a historical perspective**	• Maarten Bijleveld van Lexmond Chairman TFSP Neuchâtel, Switzerland
10.20 – 11.00	**The Worldwide integrated assessment on systemic pesticides**: Neonicotinoids, pollinators, biodiversity and food	• Jean-Marc Bonmatin CNRS-Center for Molecular Biophysics (CBM), Orléans, France
11:00 – 11:40	**Systemic pesticides in aquatic environments and implications for the large**	• Francisco Sánchez-Bayo, Faculty Agriculture & Environment

	ecosystem	University of Sydney, Australia
11:40 – 12:00	**Use of systemic pesticides in the developing world. A case study from the Philippines** followed by **the film of TFSP**	• Elizabeth Lumawig-Heitzmann Marinduque Biological Field Station, Philippines
Lunch Break		
SESSION B: Strategies for pesticide reduction and improving food safety Moderator: Yezin Agricultural University		
13:30 – 14:10	**IPM and protection of growers by a mutual insurance against pitfalls: powerful alternatives to systemic insecticides in arable crops**	• Lorenzo Furlan. Veneto Agriculture, Centre for Agricultural Research/ University of Padua, Italy
14:10 – 14:30	**Use of systemic insecticides in Myanmar**	• Ohn Mar Lynn Associate Professor Yezin Agricultural University
14:30 – 14:50	**Pesticide uses, pests and beneficial insects in Myanmar**	• Ah Nge Htwe Lecturer Yezin Agricultural University
14:50 – 15:10	**The species composition of predator of rice insect pest in Nay Pyi Taw Area**	• Moe Hnin Phyu Lecturer Yezin Agricultural University
Tea break		
15:30 – 15:50	**Ecological engineering - a strategy for rice production without neonicotinoids in Asia**	• Kong Luen Heong Selangor, Malaysia
3:50 – 4:10	Panel discussion to meet questions /discussion	
4:10 – 4:25	Discussion on international collaboration	
4:25 – 4:30	Closing remarks	• Prof. Dr. Myo Kywe Rector of Yezin Agricultural University

Systemic Pesticides and the International Task Force on Systemic Pesticides, a historical perspective

Maarten Bijleveld van Lexmond

Chairman Task Force on Systemic Pesticides (TFSP)
46, Pertuis-du-Sault, 2000 Neuchâtel, Switzerland

In July 2009, a group of entomologists and ornithologists met at Notre Dame de Londres, a small village in the French Department of Hérault, as a result of an international enquiry amongst entomologists on the catastrophic decline of insects (and arthropods in general) all over Europe. They noted that after a perceptible and gradual decline of insects from the 1950's onwards, a much steeper decline in insect populations had started in the decade 1990-2000. This first began in Western Europe, followed by eastern and southern Europe, and is best documented in the decline of butterflies and the global disorders amongst honeybees. They concluded that these phenomena reflected the now general collapse of Europe's entomofauna. On the basis of existing studies and overwhelming circumstantial evidence, they came to the hypothesis that the new generation of pesticides, the persistent, systemic and neurotoxic neonicotinoids and fipronil, invented and introduced in the early 1990s, are likely responsible at least in part for these declines. They, therefore, issued the Appeal of Notre Dame de Londres under the heading "No Silent Spring again" referring to Rachel Carson's book "Silent Spring" then published almost half a century ago. In response, an international Task Force on Systemic Pesticides was set up at the end of 2009. Over the years, membership grew and today counts 17 nationalities in four continents. In undertaking the Worldwide Integrated Assessment (WIA), over the course of the last four years, the TFSP has examined over 1.100 scientific peer-reviewed papers published over the last two decades. The WIA was almost simultaneously launched in June 2014, and published in a special issue of the peer-reviewed Springer journal "Environmental Science and Pollution Research" in January 2015. The TFSP's scientific assessment indicates that the current large-scale prophylactic use of systemic insecticides is having significant unintended ecological consequences. The evidence indicates that levels of systemic pesticides that have been documented in the environment are sufficient to cause adverse impacts on a wide range of non-target organisms in terrestrial, aquatic, wetland, marine and benthic habitats. There is also a growing body of evidence that these effects pose risks to ecosystem functioning such as for example pollination and nutrient cycling, as well as to human health.

Maarten Bijleveld van Lexmond

Maarten Bijleveld van Lexmond is a biologist and conservationist by training. He studied at Leiden and Amsterdam Universities obtaining his PhD in 1974 with the publication of his first book: Birds of Prey in Europe. As one of the founders of the World Wildlife Fund in the Netherlands he joined the WWF international secretariat in Switzerland and later led the Commission on Ecology of the International Union for the Conservation of Nature (IUCN). In the mid-eighties he founded the Swiss Tropical Gardens in Neuchatel, now in Kerzers (Switzerland), in parallel with the Shipstern Nature Reserve in Belize, Central America. For many years he also served as President of the Foundation for the Conservation of the Bearded Vulture, which succeeded in reintroducing the species into the Alps and other parts of Europe. At present, dividing his time between Switzerland and the south of France most of it since 2009 is taken up by his function as Chairman of the International Task Force on Systemic Pesticides (TFSP) which now looks into the worldwide impact of these chemicals on biodiversity and ecosystems, and in particular on pollinators such as honey bees, bumble bees, butterflies, but also at suspected consequences for public health.

Email: mbvl@club-internet.fr

World-wide integrated assessment on systemic pesticides:Neonicotinoids, pollinators, biodiversity and food

Jean-Marc Bonmatin

Deputy Chairman TFSP, Centre National de la Recherche Scientifique, Centre de Biophysique Moléculaire, rue Charles Sadron, 45071 Orléans Cedex 02, France

Neonicotinoids constitute a small family of insecticides acting on the central nervous system (nAChRs). They are often preventively used as seed dressing, foliar sprays, tree injections, etc. They represent about one third of the insecticide market worldwide, particularly in America, Europe and Asia, for diverse arable, horticultural and forest crops. Every year, mean losses of about 30% of honey bee colonies occur in countries where agriculture is intensive. These bee disorders are recognized worldwide by IPBES*, and IUCN founds that 9% of bees are threatened with extinction in Europe** Pesticides, and particularly neonicotinoids insecticides, are involved in colony losses of both honey bees and wild bees such as bumblebees (DOI: 10.1016/j.cosust.2013.05.007; DOI: 10.1126/science.1259159; DOI: 10.1126/science.1255957). Bee disorders are accompanied by a general collapse of entomofauna. A Worldwide integrated assessment on systemic pesticides was carried out to explore the role of neonicotinoids (DOI: 10.1007/s11356-014-3220-1). Our meta-analysis has described the uses and metabolism in soil, plants, water and air (DOI: 10.1007/s11356-014-3470-y). The environmental fate and exposures via these compartments (DOI: 10.1007/s11356-014-3332-7) have been linked to large effects on non-target invertebrates (aquatic and terrestrial, DOI: 10.1007/s11356-014-3471-x), and on vertebrates such as fishes and birds (DOI: 10.1007/s11356-014-3180-5). Neonicotinoids threaten agricultural productivity through their impact on ecosystem functioning and services (DOI: 10.1007/s11356-014-3277-x). More sustainable approaches are readily available, both in agriculture and forestry (DOI: 10.1007/s11356-014-3628-7). Three neonicotinoids have been restricted in Europe (2013), but our conclusions and conclusions from EASAC*** support further restrictions of their prophylactic uses (DOI: 0.1007/s11356-014-3229-5) in favour of integrated pest managements (IPM) practices which minimize pesticide use, and therefore the contamination of our food. This work has been supported by the Triodos foundation.

Jean-Marc Bonmatin

Jean-Marc BONMATIN is researcher for the Centre National de la Recherche Scientifique (CNRS, France). He completed his thesis in 1987 (Chemistry and Physics) by studying biological membranes in interactions with various peptides, especially a bee venom. Just after, he worked for the National Research Council of Canada (Ottawa, Canada) until 1989. Here, he was interested in dynamics of cholesterol in membranes. He joined the Centre de Biophysique Moleculaire late 1989 (CBM, CNRS, Orleans, France) where he started his researches on structure-activity relationships of various natural toxicants (antibacterial, antifungal, neurotoxins, etc.). From 2008 he was involved during twelve years in coordination of European research programs on the Colony Collapse Disorder (CCD). This concerned analytics of insecticides in soil, water, pollen and honey, as well as the finding of the first virus of bee mites (Varroa destructor). From 2009 he also joined the Task Force on Systemic Pesticides, being now the vice-chairman. He is also involved in risk assessments for pollinators for several public organisms such as ITSAP (French Institute of Bee and Pollination), ANSES (French Agency of Environmental and Food Safety) and OECD. (https://www.triodosfoundation.nl/nl/bijen-triodos-foundation/)
*http://www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat
**http://ec.europa.eu/environment/nature/conservation/species/redlist/downloads/European_bees.pdf

Email: bonmatin@cnrs-orleans.fr

Systemic pesticides in aquatic environments and implications for the large ecosystem.

Francisco Sánchez-Bayo

Faculty Agriculture & Environment, The University of Sydney, Australia Department of Plant and Food Sciences, Faculty of Agriculture & Environment, The University of Sydney, 1 Central Avenue, C81 - ATP Eveleigh, NSW 2015, Australia

The widespread use of systemic insecticides in agriculture, which comprise mostly neonicotinoids, results first in contamination of the soil in the treated crops, and secondly in the transfer of residues to the aquatic environment. The high toxicity of these insecticides to aquatic insects and other arthropods has been recognised, including their time-cumulative toxicity after sub-lethal exposures. However, there is little awareness of the impacts that these chemicals have on aquatic environments despite their well-known hydrophilic properties and persistence. Recent monitoring studies throughout the world have revealed a larger than expected contamination of creeks, rivers and lakes with these insecticides, although the residue levels are still in the low µg/L (ppb) range. It should be realised the relevance of such concentrations for the health of aquatic ecosystems, because they are increasing rapidly in both their frequency and concentrations. The extent of aquatic contamination by neonicotinoids is contrasted with the known acute and chronic toxicity of these chemicals to various aquatic organisms, revealing that up to 40% of species are currently affected in some regions. However, simple predictions of risk based on toxicological and monitoring data are insufficient to understand the real impacts that such chemicals may have on ecosystems. Examples of impacts on populations and aquatic communities, mostly using mesocosms, will be shown. A comparison of the findings of theses studies with toxicological data helps sort out the communities most at risk from those that undergo little or no impact. Finally, the ecological links between aquatic and terrestrial organisms are considered. Two essential ecological aspects will be discussed: i) impairment of the organic matter decomposition carried out by aquatic detritivorous species, and ii) starvation of insectivorous amphibian and terrestrial species due to elimination of their main food sources – the arthropods. The consequences for other species in the ecosystem that depend mainly on invertebrate food sources pose a real and present threat to the biodiversity of the planet. Difficulties in obtaining long-term experimental data that relates the direct effects on arthropods to indirect impacts on vertebrate populations and ecosystems are recognised; they explain our current gaps in knowledge about the ecological damage that stems from the large-scale use of these insecticides.

Francisco Sánchez-Bayo

Dr. Francisco Sánchez-Bayo, PhD. School of Life & Environmental Sciences, Faculty Agriculture & Environment, The University of Sydney, 1 Central Avenue, C81 – Australian Technology Park, Eveleigh, NSW 2015, Australia

Dr Sánchez-Bayo was born in Spain and studied at the Autonomous University of Madrid, where he obtained a Master's degree in Environmental Sciences and a doctorate in Ecology. After a post-doctoral stint in Australia, he worked and taught for five years as an Assistant Professor at Chiba University, Japan where he became concerned about the ecological impacts of neonicotinoids in paddy fields. Back in Australia, he worked for the Office of the Environment & Heritage NSW and is currently Honorary Associate at the Faculty of Agriculture & Environment of the University of Sydney. He is author and co-author of over seventy scientific articles and book chapters on the environmental impact and risk of pesticides, ecology and related subjects, and co-authored and edited the book "Ecological Impacts of Toxic Chemicals". He serves as reviewer of some 40 international journals and acts as expert assessor for evaluating scientific projects in seven countries. In the article "The trouble with Neonicotinoids" published in Science in November 2014 he largely confirmed the findings of the "Worldwide Integrated Assessment of the Impact of Systemic Pesticides on Biodiversity and Ecosystems" published later that year.

Email: sanchezbayo@mac.com

Usage of Systemic Pesticides in the Philippines

Elizabeth Lumawig-Heitzmann

Secretary of TFSP Public Health Working Group, Marinduque Biological Field Station.
Cawit, Marinduque, Philippines

Usage of Systemic Pesticides in the Philippines. Like in other Asian counties use of neonicotinoid pesticides is widespread in the Philippines. Given the virtual absence of marketing regulations these products can be sold under multiple trade names at the lowest retailer levels with the well-entrenched agrochemical industry strengthening its marketing networks, penetrating into local villages. In addition, the pesticide regulatory process appears to be far too pro-industry to play an effective role. From 2011 statistics it appears that the three principle neonicotinoid pesticide, clothianidin, imidacloprid, and thiamethoxam, are being sold under 13 different brand names and imported, however, is available and an early survey of usage of neonicotinoid pesticides around nature reserves was discontinued. The Worldwide Integrated Assessment on the Impact of Systemic Pesticides (TFSP) was first launched in Manila in June 2014 to be followed in hours by press conference in Brussels, Ottawa and Tokyo. In response to the WIA the Governor of the Province of Marinduque in order to protect the island's famous butterfly breeding industry, declare to ban all usage, sale and importation of Neonicotinoid pesticides and Fipronil, an initiative that awaits its implementation. As an immediate result of the symposium hosted by the De La Salle University in Manila in June 2016, the University, in cooperation with TFSP, has now embarked on a first project to assess the impact of systemic pesticides on the Philippine environment, while the establishment of a biological field station is being prepared amidst and in support of the national butterfly industry.

Elizabeth Lumawig-Heitzmann

Ms. Elizabeth Lumawig-Heitzmann, BSc, Secretary of TFSP Public Health Working Group, Marinduque Biological Field Station. Cawit, Marinduque, Philippines.

Elizabeth Lumawig-Heitzmann was born in Manila, Philippines, where she grew up in a household immersed in entomology. Her parents collected and discovered Philippine butterflies and other insects, some of which have been named after members of her family. In 1986, she received a BS in Secondary Education with a major in Biology and a minor in Earth Science. In 1996, she established the first butterfly house in the Philippines in Quezon City. She has been the owner of Flora Farm (Butterfly House) since 1991, and serves as the director of the Philippine Exotic Butterfly Fund and as Director of the Subic Bay Freeport Zone Butterfly Garden & Breeding Centre since 2004. During her professional career, she routinely conducted seminars on butterfly farming and watershed management, served as an expert for the Department of Environment and Natural Resources (DENR), advised or managed butterfly houses and trails for provincial governments in the Philippines, and served as a consultant on the Livelihood Project on Butterfly Breeding. She previously served as the honorary secretary of IABES External Liaison Committee in 2009, and as a member of the IUCN Task Force on Systemic Pesticides representing the Philippine Protected Ares and Wildlife Bureau in 2011. She is currently the Hon. Sec. of TFSP Public Health Working Group. She now heads the Marinduque Biological Field Station.

Email: beth_heitzmann@yahoo.com

Social and policy issues related to pesticide reduction.

K. L. Heong

Zhejiang University, Zijingang Campus, Hangzhou, China.

A large proportion of pesticides used in Asian agriculture has low efficiency. In the Philippines about 80% of the insecticide sprays applied was found to be misused resulting in no productivity gains. Among the reasons causing this are pesticides are often applied on a routine basis with poor spray equipment thus miss pest targets resulting in greater environmental damages. In addition pesticides in Asia are sold as FMCGs (fast moving consumer goods), with hundreds of trade names by unlicensed retailers violating the FAO-WHO International Code of Conduct on Pesticide Management (2014). The diversity of products and trade names in highly unregulated markets create confusion among farmers who end up rely on the retailers for advice.

Because of misuse, the productivity gains of rice farmers' insecticide use are low and often negative. There are thus potential opportunities for reduction by at least 30% without compromising national production that will result in increasing farmers' incomes. To achieve this would require not only technical innovations, like resistant varieties, IPM and ecological engineering techniques, but innovations in social and policy change processes. At present pest management information supply is dominated by unlicensed retailers with mainly profit objectives and the unregulated marketing encourages products to be sold in numerous names, with aggressive advertising and attractive sales incentives.

Current approaches to pesticide reduction mainly focus on banning products, running reduction campaigns and farmer training. They may be effective in the short term but are not sustainable as they do not manage with the root causes, like pesticide market regulations and licensing of retailers. In Indonesia millions of US$ have been spent in training farmers using Farmer Field Schools (FFS) but insecticide use escalated after the training programs stopped due mainly to the pesticide industry's aggressive market tactics.

A comprehensive and sustainable pesticide reduction program must therefore include

1) Development of pest management strategies and methods based on utilizing biodiversity as the foundation that will maximize ecosystem services and decrease adverse effects on crop health, environment health and human health.
2) Using the appropriate pesticides only as the last resort.
3) Development and strengthening of pesticide marketing regulatory frameworks to prevent pesticides being sold as FMCGs, in pyramid market schemes by unlicensed and unqualified individuals or sectors.
4) Government and private sectors must comply by the FAO & WHO International Code of Conduct on Pesticide Management (2014) endorsed by countries of the UN and pesticide companies.
5) Development of a plant protection professional certification program to ensure quality of services and sale of pesticides.

K. L. Heong

Dr. K. L. Heong, DSc PhD DIC FASc, Qiushi Chair Professor, Zhejiang University, Hangzhou, PR CHINA.

Dr Kong Luen Heong, a Malaysian citizen, is a fellow of The World Academy of Science (TWAS) and the Malaysian Academy of Science (ASM) and holds both a PhD and a DSc from Imperial College, London. Formerly a Principal Scientist and an insect ecologist in the International Rice Research Institute(IRRI) he is now the Qiushi Chair Professor in Zhejiang University, China, an adjunct professor in Universiti Putra Malaysia (UPM) and the senior advisor to the Centre for Agricultural BioSciences International (CABI), South East Asia Regional Centre based in Malaysia.

His work to develop, communicate and implement innovations in restoring biodiversity, introducing ecological engineering methods and reducing pesticide use in rice production in Asia has been recognized by the US Council for Agricultural Science &Technology (Charles Black Award) for exemplary contributions to public understanding if food and agricultural sciences), The World Academy of Sciences(Agriculture Prize),the International Association of Plant Protection (IAPPS) (Award of Distinction) for contributions toward the development of plant protection strategies and the promotion of global food security), the Malaysian Plant Protection Society (Excellence Prize) and 2 Gold Medals from the Government of Vietnam. He has also won the St Andrews Prize for Environment, the World Bank Marketplace Award, the COM+ Award for communicating science, Vietnam's Golden Rice Award and the Westlake Friendship Award from Zhejiang province, China.

Dr Heong has published more than 250 peer review journal papers, several books and has led several international projects with budgets of more than US$ 7 million.

Email: klheong@zju.edu.cn

IPM AND Protection of growers by a mutual insurance against pitfalls: powerful alternatives to neonicotinoids in arable crops

Lorenzo Furlan

PhD Chairman TFSP Working group on Alternatives; Veneto Agricultura, Centre for Agricultural Research in Co-operation with the University of Padua, Italy

An extensive survey of fields and numerous trials conducted over the last 30 years in Italy made possible a reliable risk assessment of maize damage by soil pests and the implementation of IPM. Strong risk factors include organic matter content >5%, rotations including meadows and alfalfa, double crops one year or two years before maize is sown and landscape around the maize fields including meadows and/or natural grass, alfalfa and double crops. Weaker risk factors include a poor field drainage, late sowing date, a warm spring and clay or loam clay soils. The statistical models also showed how the simultaneous occurrence of two or more of the aforementioned risk factors can conspicuously increase the risk of wireworm damage to maize crop, while the probability of damage for a field with no risk factors is always low (<1%). IPM includes two steps:

1) "Area-wide" risk assessment including click-beetle population monitoring with pheromone traps: risk factors evaluation enables each cultivated region to be mapped and high-risk areas to be pinpointed. The first layer of the risk map includes the main soil characteristics (organic matter content, texture, PH); the second includes the key agronomic characteristics (rotation, drainage); and the third, the available entomological information, such as click-beetle population levels for the main Agriotes species, or wireworm presence/density assessed with bait traps over the years. A fourth layer reproduces the effects that occur when existing risk factors interact. This system enables areas with different risk levels to be highlighted. Each wire-worm risk category (e.g. low, medium or high, based on the presence of one or more risk factors) will have its own IPM strategy.

2) Complementary field monitoring: where risk factors are present, the suggestion is to assess actual wireworm populations using bait traps, and if the average number does not exceed thresholds established, maize may be sown without any treatment; if the average number of wireworms exceeds at least one of the thresholds, farmers have the option of moving maize to a no-risk field, as well as of applying organic treatments or, as the last resort, chemical treatments.

In this way, control strategies will be implemented only when and where economic thresholds for maize are exceeded.

Assessing the risk of wireworm damage affords a solid basis for estimating the amount of farmland that can be left untreated each season without any risk of yield reduction. Precise targets for IPM of soil pests in maize could be set anywhere. For instance, in no-risk areas, soil insecticides or insecticide-coated seeds may need to be used on no more than 1% of maize-cultivated land, and in areas where organic matter content is over 5%, soil insecticides could be used on about 15% of maize-cultivated land. For large areas with scattered-risk situations, IPM targets will be a balanced mean of the damage risk caused by various risk factors and the surface area of cultivated land where each risk factor occurs. In order to facilitate IPM, risk insurance coverage may be extremely useful. Insurance can be taken out privately by associated farmers, or with the support of public regulations. With risks below 1%, a few dollars per hectare (ten times less than soil-insecticide costs) would be enough to pay for damaged fields. As a result, the described IPM strategy may lead to a considerable reduction in the use of soil pesticides and to the immediate containment of the environmental impact of agriculture with no negative repercussions on farmers' income.

Lorenzo Furlan

Dr. Lorenzo Furlan, PhD, Chairman TFSP Working group on Alternatives; Veneto Agricultura, Centre for Agricultural Research in Co-operation with the University of Padua, Italy.
Lorenzo FURLAN graduated in Agricultural Sciences at the University of Padua, has been working on soil insects (wireworms, black cutworms, Diabrotica virgifera virgifera) and on implementation of sustainable agriculture since 1981. He is currently the Manager of the Agricultural Research Department at Veneto Agricultura (an extension Service for regional agricultural activities) where he is in charge of running the pilot farms and the research activity. Significant part of his research is devoted to 1PM strategies against pests of arable crops. He is reviewer and the author or co-author of more than 200 papers in national and international Journals; among them the description of practical 1PM strategies suitable for a dramatic reduction of soil insecticide usage in Europe.
Email: lorenzo.furlan@venetoagricoltura.org