Background

CropLife Africa Middle East is a not-for-profit industry association representing global manufacturers of pesticides, seeds and biotechnology products in its territory. The regional association linked with the global CropLife network also represents more than 20 national associations across Africa and the Middle East and seeks to make the most of plant science’s great potential to improve sustainable agriculture and promote responsible development and sustainable use of plant science technologies.

Since its creation, the association’s strategy is focused on supporting:

- responsible use and compliance throughout the food production chain as stipulated in the code of conduct (CoC)
- science based regulatory processes that encourage development and access to innovation, while setting standards for safety and sustainability, and
- alleviation of counterfeiting and illegal pesticides through awareness creation and law enforcement

Neonicotinoids in Africa’s Agriculture

In 2018 and 2019, the Academy of Science of South Africa (ASSAf), and the Network of African Science Academies (NASAC) held two workshops involving African country experts to review literature and dialogue on the impact of neonicotinoids. The outcome, two reports raising some pertinent issues on the use of neonicotinoids in Africa’s agriculture.

As stakeholders in agriculture, our industry would like to contribute to the existing literature by availing relevant information focussing on the issues raised in the reports. The main areas of focus are the impacts on:

- Pollinators
- Human health
- Environment
- Stewardship
- Economy
Impact of Neonicotinoid Chemistry on Pollinators

Improving bee health and preventing a decline of bee populations globally is a major consideration for all involved in the sustainable production of food. Bee hive numbers globally have increased by 65% over the past 55 years (FAO data). For Africa, an increase of managed honey bee colonies by more than 140% has been recorded, whereas there are no data for feral honey bee colonies or wild bees and bumblebees. All stakeholders have concerns about increased honeybee mortalities in both North America and Europe. Crop protection industry experts along with other scientists are evaluating many factors to better understand the factors impacting bee health. Of which there are many including diseases caused by viruses, bacteria, fungi, and mites – interactions between Varroa mites and viruses play an important role in bee mortality. Other contributory factors such as poor nutrition (quality and quantity); adverse climatic conditions; lack of genetic diversity and lineage; incorrectly applied veterinary treatments, irresponsible use of pesticides; poor beekeeping management. The range of bee health is most likely impacted by a combination of factors, consequently isolating one specific class of pesticides as a pre-eminent factor is implausible.

The collective impact of pathogens on bee health has yet to be fully quantified, but existing evidence points at Varroa and viruses as key factors behind compromised bee health.

Graph 1: Pathogens for the honeybee

Graph 2: Total US managed honey bee colony losses

Equally the impact of seasonal weather conditions on honeybees and other pollinators is very often underestimated. Although not relevant to the situation in Africa’s tropical and subtropical regions, cool, wet spring weather for instance limits the ability of honey bee colonies to forage early in the year and wet summer months can impair successful breeding.

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Pollinator-dependent crops contribute to 35 per cent of global crop production volume. Our industry is reliant upon the pollination provided by bees and other pollinators. The crop protection R&D community conduct constant research on the environmental effects of products, while helping beekeepers and encouraging farmers to maintain suitable areas for bee forage and beekeeping coexistence. Examples of such initiatives include the Operation Pollinator, Bee Care programs BeeConnected in Canada, BeeConnected and Pollinator Protection Initiative in Australia and South Africa’s Bee Chart established to promote good farming and beekeeping practices.

Hundreds of thousands of beehives around the world are used by our members for the pollination of seed production crops. Consequently, the suppliers of innovative crop protection products to the farming industry fully understand the benefits of maintaining bee populations. In order to minimize the impact on pollinators, R&D companies define pre-flowering intervals for insecticides in relation to the crops’ attractiveness and to bees and the application rate of the product. The application rates are determined from years of field and lab evaluation prior to product registration.

- Results of numerous bee, pollen and nectar residue studies show that label recommended neonicotinoid uses are safe.
- Extensive industry wide training is undertaken to ensure those using neonicotinoid based chemistry understand their wider stewardship obligations to ensure safety of users, consumers and the environment.
- Risk mitigation requirements including restrictions concerning pre-flowering applications for bee attractive crops, is actively promoted both on product labels and through stewardship training initiatives with in market channel partners; advisors and growers.

Human health: Operator exposure and consumer implications.

Neonicotinoids are a modern class of insecticides used at lower rates and applied fewer times, than many older insecticides still commonly used across Africa. For growers using insecticides neonicotinoids pose fewer operator risks in use, than all preceding groups of insecticide chemistry used across Africa. It is also worth noting that neonicotinoids are less toxic to non-target organisms than the majority of older insecticides. They have large toxicity packages prepared for evaluation by regulatory authorities and their summaries and conclusions are published and available.

As an example, thiamethoxam is non-irritating to skin and eye, nor it is mutagenic or neurotoxic. Syngenta’s thiamethoxam based products that are registered and commercialized in AME show a favourable environmental and human health safety profile. In an assessment conducted by the Health Effect Division (HED) of EPA provides favorable conclusions for

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3 https://www.syngenta.com/sustainability/operation-pollinator
4 https://beecare.bayer.com/home
thiamethoxam concerning human health. Further information on the EPA HED draft assessments and conclusions is provided below:

The toxicology database for thiamethoxam is complete and acceptable for risk assessment purpose. The scientific quality of the available toxicology studies is high and the toxicity profile of thiamethoxam has been adequately characterized, including potential carcinogenicity, mutagenicity, developmental toxicity, neurotoxicity, and immunotoxicity. Thiamethoxam is classified as “not likely to be carcinogenic to humans.” In acute lethality studies, technical thiamethoxam is slightly toxic to rats and moderately toxic to mice via the oral route of exposure (Toxicity Category III); it is of low toxicity to rats via the dermal (Toxicity Category III) and inhalation routes (Toxicity Category IV). It is not irritating to the skin, is minimally irritating to the eye, and is not a dermal sensitizer.

HED conducted acute and chronic aggregate dietary (food and drinking water) exposure assessments. The acute and chronic assessments are based on field trial residues, assume 100% crop treated, and incorporate high end estimates of thiamethoxam residues in drinking water. The acute and chronic risk estimates are not of concern for the general U.S. population or any of the population subgroups, including those comprised of infants and children. None of the resulting aggregate exposure and risk estimates were of concern for any population subgroup.

Environment - Impact on ecosystem.

Neonicotinoids pose a minimal risk to the environment when used in accordance to label advice. We note that the ASSAF meetings reports have not made reference to the FAO report on pollinators and pesticides\(^9\). This document included a section on Kenya and contains useful information about a range of insecticides and use rates.

In addition, recognition that neonicotinoids are only part of the pest control practices and seldom applied with repeated applications is important. This is especially true of smallholder farmers who often apply only one treatment of the product per season. There is still ongoing use of organophosphorus and carbamate insecticides in many countries however these should also not be applied on crops in flower without data supporting this use. Neonicotinoids have the same high hazard quotient (or HQ, an assessment of risk which takes into account both use rate and toxicity to bees) when used in flowering crops as organophosphates and carbamates, which may have lower toxicity but have higher use rates (Thompson and Thorbahn, 2009\(^10\)) and resulted in large numbers of incidents in Europe in the 1980s. This is why acutely bee-toxic neonicotinoids, organophosphorus and carbamate compounds should not be used on bee-attractive crops in flower. Neonicotinoids derived from R&D companies are generally supported with strong in-field and pack label advice.

\(^9\)http://www.fao.org/3/a-i31116e.pdf

Figure 1: Comparison of the total number of reported incidents involving pesticides and the hazard quotient (HQ) for each pesticide. The purple line indicates the HQ of 50 which is a trigger value for higher tier pollinator risk assessment.

Drawing conclusions from laboratory exposure studies showing sublethal effects and assuming they reflect behavior following field use is incorrect. There are no studies that would show any negative impact of sublethal effects of correctly applied neonicotinoids to honey bee colonies under field-realistic exposure conditions. The IPBES report demonstrates that sub lethal effects occur at neonicotinoid dose rates well below those resulting in effects at the level of the whole organism (IPBES, 2016). The EFSA Bee Guidance Document highlights that sub lethal effects identified in the laboratory cannot be linked to effects at the colony level under realistic field conditions.

Graph 3: Reported effects of neonicotinoid insecticides on individual adult honey bees

Source: IPBES report 2016

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12 https://www.efsa.europa.eu/fr/efsajournal/pub/3295
The comparison of toxicity of neonicotinoids with DDT is not relevant as the compound was not banned based on its toxicity to bees (contact LD50 50 ng/bee (Torchio, 1973) and 27 µg/bee contact toxicity\(^{13}\)). but due to its bio accumulative properties and effects on eggshell thinning in birds resulting in declines in predatory bird populations. The neonicotinoids span a class of chemistry with acute contact and oral toxicity ranging from 5 - 18,000 ng/bee. This is similar to other classes of insecticide chemistry, e.g. spinosad, many pyrethroids are as acutely toxic as the most toxic neonicotinoids.

The toxicity of thiamethoxam is well established and both chronic adult and larval data have been published which demonstrate no accumulative effects (Overmyer et al., 2018). After 10 days of continuous exposure, the NOEC for adult mortality was 117ng thiamethoxam/g. Sub lethal effects are only relevant if they relate to observable effects at the level of the colony. Colony level effects are observed following prolonged exposure to 10’s-100 ng neonicotinoids/g, e.g. for thiamethoxam at 50 ng/g; for seed treatments this is over an order of magnitude higher than residues detected in pollen and nectar collected from treated crops (Overmyer et al., 2018\(^{14}\); Thompson et al., 2019\(^{15}\)). For Imidacloprid, it has been shown that dietary concentrations of at least 20 ng/g are not causing any adverse effects to exposed honeybee colonies. The safe dietary concentration is by far higher than residues in nectar or pollen resulting from seed treatment.

Soil accumulation is not observed over years of use as shown by soil metabolism data (Hilton et al., 2019\(^{16}\); Hilton et al., 2016\(^{17}\)) and by follow-on crop pollen and nectar residue studies (Thompson et al., 2019). Neonicotinoids are highly water soluble, readily metabolised and excreted (thiamethoxam is rapidly metabolised in honeybees and clothianidin was accumulated in the rectum (not absorbed) during continuous exposure (Coulon et al., 2018\(^{18}\))). Neonicotinoids are not classified as bioaccumulative.

There is no evidence of a simple interaction between neonicotinoid exposure and pathogens such as viruses (Collison et al., 2016\(^{19}\), Collison et al., 2018\(^{20}\), Coulon et al., 2018). Nutrition is important in influencing the bees’ ability to respond to stressors probably through gut microbiota (Mogren et al., 2019\(^{21}\)).

\(^{13}\)(http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/ddt-ext.html#12


\(^{16}\)Hilton JH. Et al. (2019): The route and rate of thiamethoxam soil degradation in laboratory and outdoor incubated tests, and field studies following seed treatments or spray application. Pest Manag Sci; 75: 63–78; DOI 10.1002/ps.5168


The declines in birds in Europe started before 1990 and is predominantly related to changes in cropping practices (e.g. autumn planting replacing over-wintered stubbles https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/farming/near-you/farmland-bird-declines/). Alleged neonicotinoid use and bird population decline correlations have been published but a causal relationship has not been demonstrated. These reported declines are often limited to snapshots in time which ignore declines already occurring often due to other causes such as urbanization (Brain and Anderson, 2019\textsuperscript{22}). Significant causes of bird declines are mostly habitat-related or anthropogenic and are not homogenous; trends and factors underpinning them vary between species, countries and regions. e.g. The Mammal Society estimate that UK’s domestic cat population catches up to 275 million prey items a year, of which 55 million are birds.

**Stewardship Measures to Protect pollinators when Neonicotinoids are used.**

On April 27, 2018 a majority of EU Member States endorsed a Commission proposal to restrict the use of neonicotinoids (imidacloprid, clothianidin and thiamethoxam) to use in greenhouses only. This decision is based on an alleged risk to bees identified by the European Food Safety Authority (EFSA) using an overly conservative, scientifically questionable risk assessment approach. However, a number of member states have exemptions for specific uses, where there are no other safe alternatives.

The European Food Safety Authority’s re-evaluation of neonicotinoids, on which the restrictions were based, did not consider the safe use of the products in practice, or the contribution of existing risk mitigation measures for certain uses. EFSA based their evaluation on their “bee guidance document” which (i) is not yet legally adopted since 5 years as a significant number of EU member states continues to oppose the document; and (ii) lays down an overly conservative approach for carrying out a pollinator risk assessment which is not used by authorities anywhere else. The document imposes for instance several study requirements that are not feasible with current study methods.

The US Environmental Protection Agency (EPA) and the Canadian Pest Management Regulatory Agency (PMRA) have followed different and more science-based risk assessment approaches and principles, and consequently, have now come to different pollinator risk conclusions regarding the three neonicotinoids Imidacloprid, thiamethoxam, and clothianidin.

The regulatory challenges for the neonicotinoids in the EU are due to extreme interpretation of overly conservative guidelines. Some of the conclusions (e.g. assumptions on which the risk assessment approach is based) are not supported by the available data showing the typical behavior in the real world, e.g. honeybee foragers consuming more than 8 times their bodyweight in nectar per day.

Neonicotinoid insecticide seed usage in Africa is mainly for high value export field crop and quality vegetable seed crops rather than extensive use on field crops grown by smallholder growers. When used in field crops i.e. maize, the application across Africa is conducted by professional seed companies both local and international. Their treatment facilities are vetted by suppliers to ensure application equipment and products are calibrated to deliver the highest standards of application and compliant with required safety standards.

It is not unusual for smallholders in particular to lose 50 % + of their sown crop during early establishment. The benefits of neonicotinoids when used as a seed treatment are significant i.e. proven to increase plant stands, uniformity; vigor, better rooting (especially important when rainfall is problematic), resulting in higher yield delivery.

Bee incidents related to neonicotinoid seed treatment ‘dusting off’ have been few in number in Europe. All known incidents with dust have occurred when vacuum-pneumatic planters were used where dust may be emitted to the environment through exhaust air. Mechanical planters are by far less prone to emit dust particles from seed treatment. An incident occurred in Germany following recommendations from official services to treat corn seeds twice by accident (double rate in total) to control a quarantine pest (Diabrotica). The quality of seed treatment of some seed batches was far below the safe standards, so these batches lost an inappropriately high quantity of the insecticidal seed treatment layer as dust during handling and planting. The industry has learnt and further adapted field and treatment practices to minimize the risk of ‘dusting off’ treatment from the seed.

For active ingredient blown away as dust, we have conducted field studies collecting the total dust from vacuum pneumatic equipment. No bee incident related to neonicotinoid dust has been reported in France, following adoption of the following risk mitigations measures listed in the 2009 French regulations:

- Mandatory use of deflector on vacuum pneumatic sowing machine to direct the exhaust of airflow from the turbine toward the soil and reduce airflow speed.
- Dust levels for corn seeds must be lower than 3 g for 100 kg seeds or 0.75 g/100 000 seeds.
- Wind speed at sowing must be below 20 km/h.

Adoption of deflectors was faster in Western Europe but gradually all vacuum pneumatic sowing machines are now equipped. Since 2016, US manufacturers of sowing machines agreed to deliver only sowing machine complying with ISO norm 17962 related to dust drift reduction.

Sowing techniques in Africa are very different from Europe. The large commercial scale farms are equipped with US produced sowing machines. However, vacuum pneumatic sowing machines are not common in Africa on smaller farms. Mechanical sowing machines are more common and lead to substantially lower drift from dust of seeds. In addition, for smallholders manual planting by hand is the main method of seed planting. Consequently, the risk from neonicotinoid dust drift is even lower with this sowing practice.

The seed industry deployed a seed quality scheme in Europe in 2011. Crop specific dust reference limits are defined in this scheme. Seed production sites are audited according to the
quality scheme and then site is certified. Monitoring of dust at production level has been published and showed dust levels well below defined limits. Almost 95% of corn, sunflower, oilseed rape and sugar beet seeds in Europe are produced on certified sites. In Africa, the same dust standards are used when a product is sold to a seed company. Production is checked and constantly monitored. Risk is further reduced due to scarcity of irrigation in Africa, this drives lower seeding density for the crop to ensure each plant gets enough water.

**Economic Implications for farming**

On page 13 of the proceedings of the November 2018 workshop the following statement is made: “Questions also are raised whether neonicotinoids are even the best way of protection crops”. A study by the US Environmental Protection Agency (EPA) showed that there is no difference in the health of soybean plants treated with neonicotinoids and those not treated by any insect control treatment (Benefits of Neonicotinoid Seed Treatments to Soybean Production on EPA website)."

This statement is based on a statement which was published by US-EPA in 2014. However, this is outdated as the Biological and Economic Analysis Division (BEAD) of EPA published on December 15, 2017 (nearly 2 years before the Nairobi workshop) a revised assessment of the benefits of neonicotinoid (clothianidin, imidacloprid, thiamethoxam) seed treatments on soybeans on the mentioned webpage. In the updated version clear benefits were shown for the mid-South and Midwestern USA. Whereas for other regions of the US benefits for soybean growers were not identified. This was considered due to a combination of climatic, biological, and agronomic practices resulting in different levels of pest pressure. In conclusion BEAD estimated the total benefits of neonicotinoid seed treatments in the USA to be up to $215 m/year.

The recent EPA-BEAD soybean benefit assessment concludes that neonicotinoids seed treatment results in clear benefits for soybean growers in the mid-South and Midwestern U.S. Syngenta has data also showing benefits for farmers in other regions e.g. that soybean seed treatment with CRUISER delayed aphid populations from reaching economic threshold by 1-3 weeks and that in many trials foliar insecticide applications for aphid control were unnecessary. Other data are also showing advantages for resistance management and/or that some pests were better controlled with CRUISER seed treatment than with early foliar spray which also needs additional spray applications. We therefore propose consideration to include of more recent data from same agency stating that neonicotinoids have clear benefits.

Neonicotinoids have been authorized and used safely worldwide for around 30 years. Indeed, in West Africa prior to this there was a general reliance on organophosphate chemistry that created significant operator exposure risk and environmental harm (broad spectrum, removing both beneficial and harmful insects). Neonicotinoids brought pest selectivity (narrow spectrum) and above all reliability. This transformed the fortunes of cocoa dependent economies; enabling, 6m cocoa growers to produce on average 450-500 kg of cocoa beans per ha. In their absence a yield decrease of between 30-50% is the norm where pest infestation takes place. Such yield reductions would make the crop unsustainable for growers and contribute to a global production drop of circa 1 m tons (world production circa 4.2 m tons). In turn losing
neonicotinoids (and some pyrethroids) would further endanger cocoa tree health and resilience across West Africa.

Given, there are few effective control options for mirids - *Sahlbergella singularis* and *Distantiella Theobroma* especially at the time of cocoa 'tree flushing', when significant tree damage takes place. As it is, in excess of 50% of cocoa trees are aged or unproductive due to disease; direct pest damage or pest transmitted virus infections.

Organisations responsible for cocoa certification have been made aware of the smallholder growers' plight should neonicotinoids be removed, without access to alternatives with supporting training in use. It is not uncommon in poor seasons to find cocoa communities suffering from starvation, removing neonicotinoids will exacerbate the problem. In the short term there are few effective alternatives that would meet grower requirements at scale, due to the numbers of cocoa growers and the complexity of the geographies growing the crop.

Elsewhere in other parts of Africa and the Middle East, the removal of neonicotinoid chemistry will have a significant impact on crop productivity and viability for a number of high value export sectors. Few if any of these economies with large rural populations can replace the foreign revenue earning lost or support the farmers whose yields have collapsed. These rural economies have few alternative industries for farming communities to prosper from. As it is, Thiamethoxam based products are registered for use on over 300 crop types from nuts, citrus fruits, banana, berries, stone fruits, a range of vegetables - Root, tuber, bulb, fruiting vegetables, cereals, maize etc. The removal of neonicotinoids will impact significantly on both yields and crop health as they become an increasing target for a range of sucking and chewing pests.

In terms of agroforestry, the use of neonicotinoids contributes a number of indirect benefits

- Improved tree health – less replacement cost, especially important in Africa where replacement tree stock is challenging.

- In cocoa planted areas reduced sucking pest and mealy bug crawler damage in general. Neonicotinoids may be reducing in part the occurrence of CSSVD that is vectored by mealybugs (*Planococcus njalensis* and *P. citri*). Mealy bugs have been responsible for the death of in excess of 30 m cocoa trees in West Africa and significant yield loss where the vector has established.

- More productive trees reducing the need to replace indigenous forest. There is ample evidence around the world that improving productivity within the confines of current production zones reduces ingress into indigenous forested areas.
Conclusions

The crop protection industry recognizes the vital role pollinators play in global food production and the need to protect their health. As such, the industry is committed to support research into pollinator health and to promote farming practices that support the health of pollinators. Further crop specific impact studies are required, looking specifically at beneficial insects’ behaviour and their ability to rebound post application of narrow spectrum neonicotinoids. Otherwise, there is risk of farmers returning to broad spectrum insecticides that will have a much higher environmental impact.

Thus, it is envisaged to undertake collaborative work with several African countries to better understand local ICM requirements by specific crop types thus avoiding a generic broad-brush approach. The studies may also include the evaluation of both light and pheromone trapping technologies to help growers justify the timing and use of chosen chemistry and improve their farm profitability and protect desired beneficial insects.

In addition, the possibility of inclusion of industry experts in scientific analysis and meetings planned in the region could be considered in order to contribute to existing and new information and to collaborate on the search for solutions around pollinator health.

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