SURVEY PEGASUS SCIENCE 2023

MYCOTOXICOLOGICAL CONTAMINATION AND NUTRITIONAL COMPOSITION OF CORN IN LATIN AMERICA

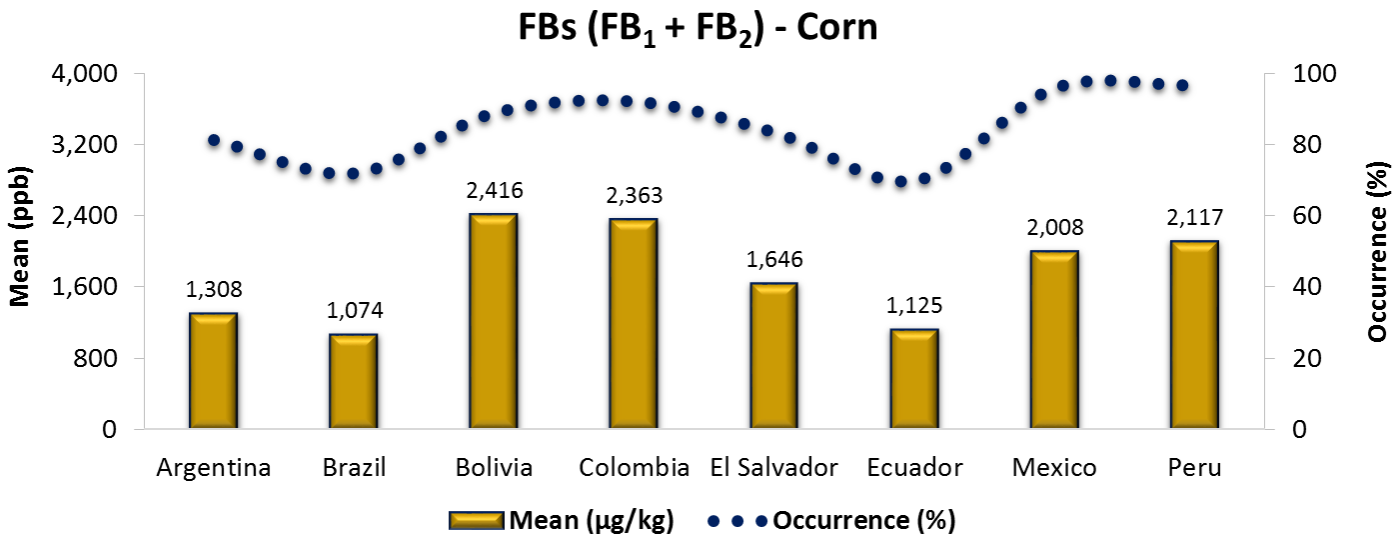
Corn is one of the most widely grown cereals in the world and is of great importance to the animal nutrition industry due to its high nutritional value. However, this cereal is susceptible to attack by fungi capable of producing **mycotoxins**, which can be present in the various stages of corn production, from the field to the final process, and are consumed in the animals' diet. The **toxic** and **immunosuppressive** effects caused by most mycotoxins have been widely documented and the contamination of corn with these substances can have a major impact on animal health, as well as **economic losses**. Therefore, **mycotoxicological monitoring** of corn is **essential** for **rapid and assertive decision-making**.

In this scenario, near-infrared reflectance (**NIRS**) technology has been widely used in the animal nutrition industry to help manage **Mycotoxin Risk** and related factors. Therefore, **Pegasus Science** is pleased to announce the results of **mycotoxicological contamination** and **nutritional composition** of **corn** marketed in **Latin American** countries, predicted by **NIRS** technology during the year **2023**.

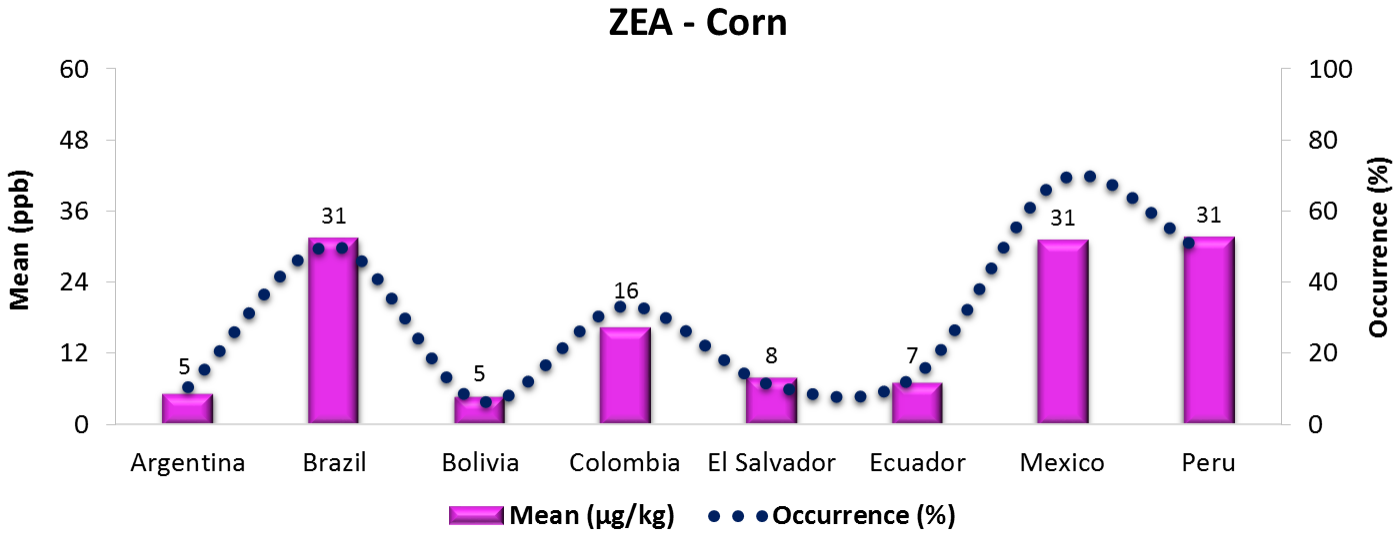
Methodology

Throughout **2023**, **17,565** spectra of **corn** samples were evaluated, totaling **143,597 predictions**. Of these, 65,622 were for mycotoxins, 16,122 for water activity (Aw) and 61,853 for nutritional composition. The spectra were derived from maize samples sold in the following countries: **Argentina** (**n=654**), **Bolivia** (**n=110**), **Brazil** (**n=15,895**), **Colombia** (**n=89**), **El Salvador** (**n=25**), **Ecuador** (**n=74**), **Mexico** (**n=132**) and **Peru** (**n=586**). The spectral information was sent via the ***Plataforma Olimpo*** (*www.olimpo.pegasusscience.com*), a **Pegasus Science** web service connected to different **NIRS** equipment located in various laboratories and industries in **Latin America**. The samples were then predicted for the presence and concentration of fumonisins B_1 and B_2 (FBs), aflatoxin B_1 (AFB_1), deoxynivalenol (DON), zearalenone (ZEA), Aw, crude protein, ether extract, starch and apparent metabolizable energy for poultry and pigs. The limits of quantification (LOQ - in ppb) for FB_1, FB_2, AFB_1, DON and ZEA were 200, 200, 5, 350 and 30, respectively.

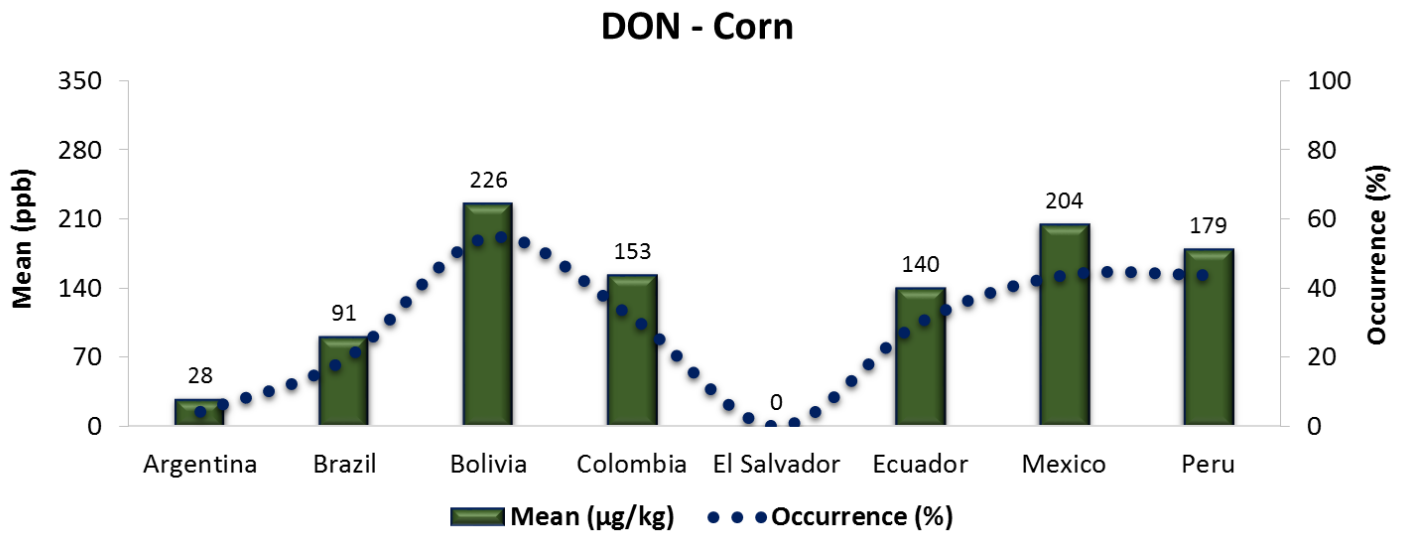
Results



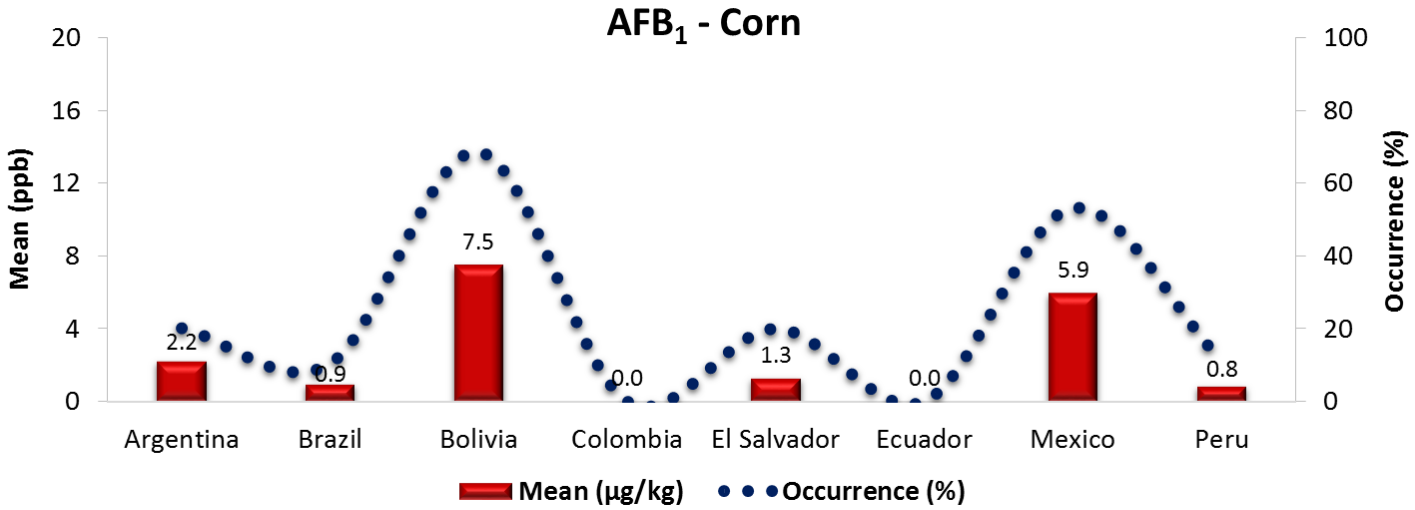
FBs were the **most prevalent** mycotoxins in Latin America, being detected in **84.9%** of the samples. The overall mean in **2023** was **1,757 ppb** and the mean of positive samples was **1,992 ppb**. **Brazil** had the lowest mean for FBs (**1,074 ppb**) while **Bolivia** had the highest (**2,416 ppb**). The concentration of FBs in the samples ranged from **0** to **11,323 ppb**. The high occurrence of FBs contamination in corn is expected since the climate in these countries favors the growth of ***Fusarium*** genus fungi, which produce this toxin.



The second most prevalent toxin was **ZEA**, which was found in **30%** of the samples analyzed. The overall mean and the mean of the positive samples were **16** and **57 ppb**, respectively. **Argentina** and **Bolivia** had the lowest means for ZEA (**5 ppb**), while **Brazil, Mexico** and **Peru** had the highest means (**31 ppb**). The concentration of ZEA in the samples ranged from **0** to **538 ppb**. Historically, the occurrence and means of ZEA contamination in corn **were low**. However, in recent years there has been a significant **increase** in the **levels of this mycotoxin**, especially in some regions of Brazil, which explains its higher annual average.



DON was detected in **28%** of the samples, being the third most prevalent mycotoxin in this survey. Its overall mean was **127 ppb** and the mean of the positive samples was **422 ppb**. **Argentina** and **El Salvador** had the lowest means for DON (**28** and **0 ppb**, respectively), while **Bolivia** and **Mexico** had the highest means (**226** and **204 ppb**). The range of DON in the samples was from **0** to **1,382 ppb**. This mycotoxin is generally one of the **least prevalent** in corn. However, in recent years there has been an **increase** in its **occurrence** and **concentration**, especially in some regions of Brazil.

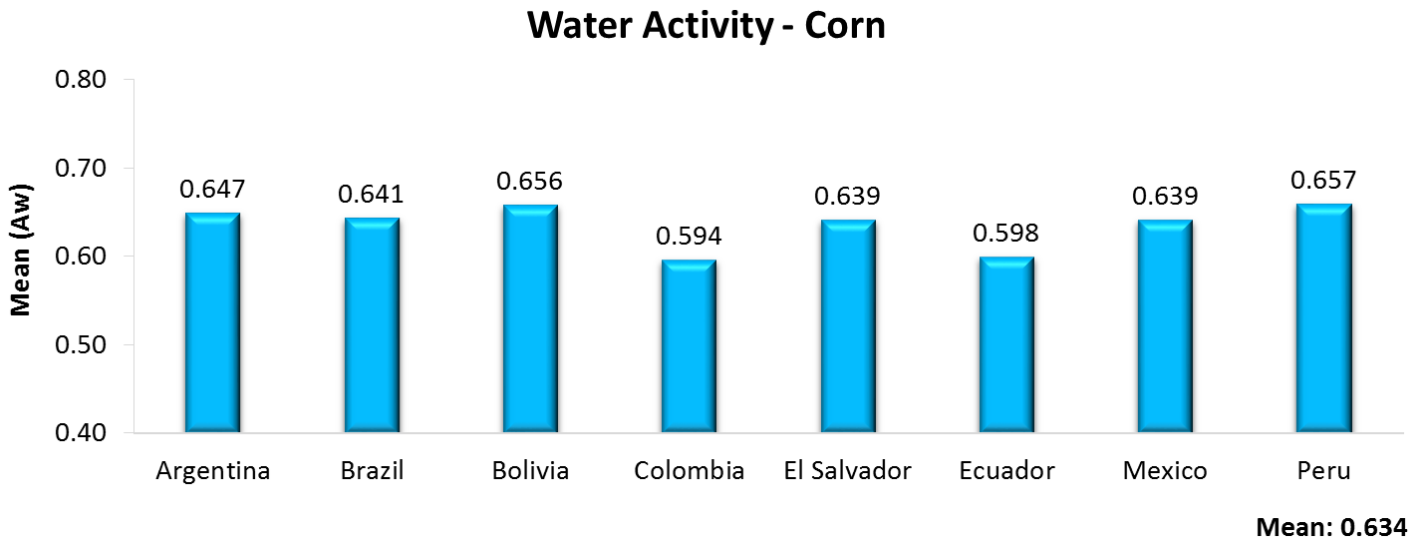


The annual mean of **AFB_1** and the mean of positive samples were **2.3** and **6.9 ppb**, respectively, and this was the **least prevalent** mycotoxin in this survey (**23%**). In **Colombia** and **Ecuador**, this mycotoxin was not detected in any sample, while **Bolivia** had the highest contamination mean (**7.5 ppb**) among the countries. The concentration of AFB_1 in the samples ranged from **0** to **30 ppb**. This mycotoxin has shown low levels of contamination over the last few years, probably due to a better control of the processes involved on its occurrence, especially the grain storage.

Mycotoxins co-occurrence in corn					
Combinations	**n**	**Occurerence (%)**	**Mean 1 (ppb)**	**Mean 2 (ppb)**	**Mean3 (ppb)**
FBs + ZEA	16,085	34.4	1,106.4	30.2	-
FBs + DON	15,492	15.5	1,142.7	93.7	-
FBs + AFB_1	15,714	9.4	1,129.8	0.95	-
FBs + DON + ZEA	15,242	7.7	1,119.7	93.2	29.8
AFB_1+ DON	15,182	3.0	0.92	94.1	-
AFB_1+ FBs + ZEA	15,491	3.0	0.94	1,110.1	30.1
AFB_1+ FBs + DON	15,182	2.6	0.92	1,126.5	94.1
Total analyses	**108,388**				

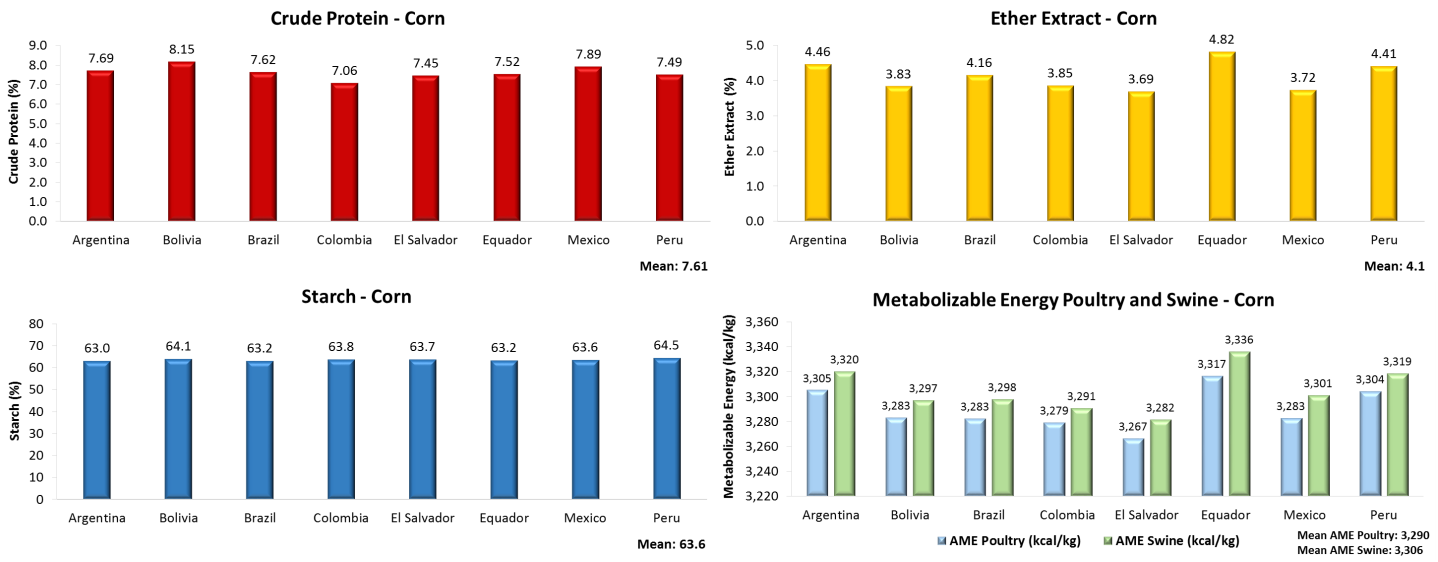
In **2023**, **91%** of the samples were contaminated with **at least one mycotoxin**, and only **9%** of the samples had no mycotoxin detected. With regard to mycotoxicological interaction, there was a higher frequency of combination between mycotoxins produced by fungi of the ***Fusarium*** genus. In **2023**, the most significant combination was between **FBs** and **ZEA**, detected in **34.4%** of the spectra analyzed. The second and third highest prevalences were found in combinations of **FBs** + **DON** and **FBs** + **AFB_1**, making up **15.5%** and **9.4%** of the predictions, respectively. Contaminations with associations between three mycotoxins were less frequent.

The **simultaneous contamination** (**co-occurrence**) of grains by different mycotoxins is mainly associated with the fact that a single genus of fungus is capable of producing different mycotoxins and can contaminate corn from the field to the storage of grains in silos or warehouses. However, there can be associations of mycotoxins produced by different fungal genera, such as **FBs** + **AFB_1**. The co-occurrence of mycotoxins in a given product can have additive, synergistic or antagonistic effects, depending on the toxins and the effects on each animal species.



Throughout **2023**, the **water activity** (**Aw**) **mean** found in Latin American countries was **0.634**, ranging from **0.594** (**Colombia**) to **0.657** (**Peru**). In addition, **23%** of the predicted samples were

above the limit considered safe (> **0.70**). Aw is an important information when it comes to the stability of any food. Values **above** the limit of **0.70** might indicate that there are conditions for **fungi** to **proliferate** and **produce mycotoxins**. Therefore, **Aw** is one of the critical factors in **grain preservation** and it is important to **monitor** it, especially **during storage**, to help **controlling fungal growth** and **mycotoxin production**. In the global assessment of the datasets presented in this survey, there is a **risk** in almost ¼ (23%) of the corn used in **Latin America**. Therefore, special **attention** should be given to this parameter.



The graphs above show the results of the **nutritional composition** of corn in Latin American countries throughout **2023**. The overall mean of **crude protein** was **7.61%**, with **Colombia** having **the lowest** mean (**7.06%**) and **Bolivia the highest** (**8.15%**). Variations were also observed in the levels of **ether extract**, with **El Salvador** having **the lowest** mean (**3.69%**) and **Ecuador the highest** (**4.82%**). There was little variability in the concentration of **starch** among countries, with means ranging from **63%** (**Argentina**) to **64.5%** (**Peru**). **Apparent Metabolizable Energy** (**AME**) levels also showed different results among countries, ranging from **3,267** (**El Salvador**) to **3,317 kcal/kg** (**Ecuador**) for **poultry** and from **3,282** (**El Salvador**) to **3,336 kcal/kg** (**Ecuador**) for **pigs**. The average annual EMA was **3,290 kcal/kg** for **poultry** and **3,306 kcal/kg** for **pigs**.

Conclusion

The most important and prevalent mycotoxins in corn marketed in Latin American countries have shown some commonly differences over the last few years. The **main findings** of the survey carried out in **2023** were the high prevalence of **FBs**, an increase in the prevalence and contamination of **ZEA** and **DON** compared to previous years and a low to moderate prevalence of **AFB$_1$**.

The risk that each mycotoxin poses to the production system must be measured by **continuously monitoring** the raw materials used in feed production. The use of **fast** and **reliable technologies** helps the company to make more assertive and cost-effective decisions. The utilization of **NIRS** to predict mycotoxins provides quick results, allowing a greater number of analyses to be carried out and ensuring greater safety and assertiveness in the use of ingredients. In addition to the concentration and prevalence of each mycotoxin, other factors must be observed in order to know the degree of **Mycotoxin Risk**: simultaneous occurrence of different mycotoxins (**co-**

occurrence), sensitivity of each animal species, in its different stages and sexes, as well as environmental, health, genetic and nutritional factors to which the animals are exposed.

Corn has traditionally been seen as a homogeneous product with minimal variations in its composition. However, advances in analytical techniques have revealed substantial **variations** in the **nutritional composition** of **corn**. These variations can affect the precise formulation of the diet, leading to **negative impacts** on **animal performance** and, consequently, **economic losses**. In general, the factors that affect the composition of corn are the result of genetic or environmental aspects, such as different corn varieties, soil types, fertilization levels and climatic conditions. In the present investigation, variations were observed in the nutritional composition of corn from different **Latin American** countries, mainly in relation to **crude protein** and **ether extract** levels.

To find out more about how to evaluate all these factors and have full access to the management tools available in real time on the **Plataforma Olimpo**, contact the **Pegasus Science** team.

Pegasus Science provides technical assistance in various areas related to mycotoxins:

✓*Mycotoxins analyses by **NIRS**;*

✓*Nutritional composition analyses of corn by **NIRS**;*

✓*Evaluation of the **MYCOTOXINS RISK** through the **Plataforma Olimpo**;*

✓*Sampling plans;*

✓*Mapping silos and warehouses;*

✓*Consultancy on mycotoxins and mycotoxicosis;*

✓*Evaluation of experiments with corn and wheat hybrids.*

Get in touch with us to find out more!