PAEPARD

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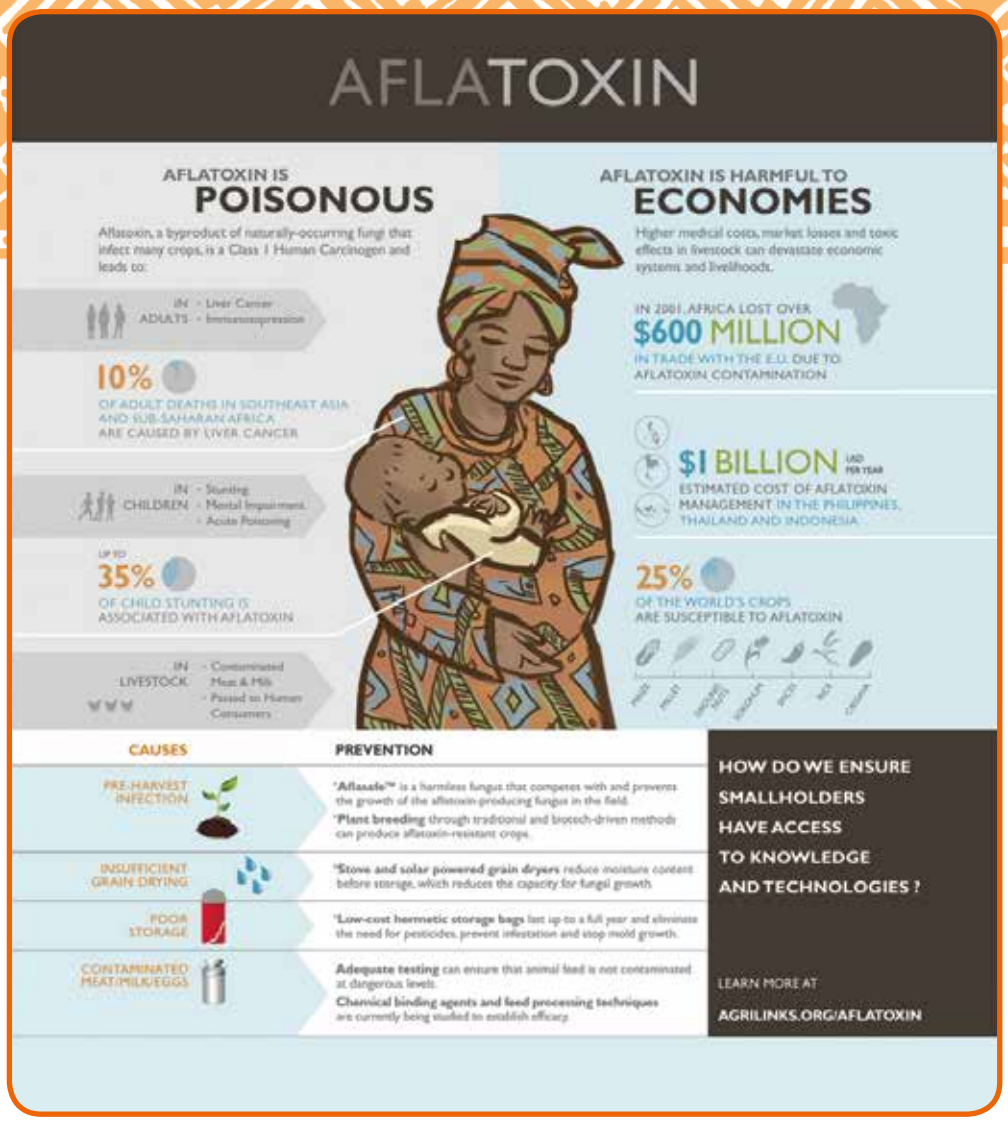
Forum for Agricultural Research in Africa

The role of multi-stakeholder partnerships between Africa and Europe exemplified by the issue of aflatoxin contamination of food and feed



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POLICY BRIEF

N°1
OCTOBER
2015

Main recommendations

Since 2010 PAEPARD has been promoting, through multi-stakeholder partnerships and brokerage between research organizations, NGOs, farmers' organizations and the private sector, innovation processes which create initiatives or add value to the existing ones in various value chains.

> Bridging the research and development gap

The Aflatoxin contamination of food and feed requires a development and research policy which translates research outcomes into practical ways which can bridge the gap between (a) research and the development of safe food and feed, and (b) different actors and (c) often parallel, initiatives. For two decades now the problem of aflatoxin has been mainly confined to the research area. Development actors are getting mobilized to tackle the problem, but bridging research and development in this field is still challenging due to the complexity of the contamination sources at pre-harvest and post-harvest levels. Nothing illustrates the interface between agriculture and nutrition as appropriately as the present aflatoxin issue. Aflatoxin-reduced staple foods and feed would be an agricultural result with a considerable health and food safety impact.

> Support national strategies

Aflatoxin contamination of food and feed is a common problem in tropical countries and in particular in African countries that have deficiencies in their storage and post-harvest handling processes. Occasionally such contamination occurs also in Europe. Unlike in the European Union where there are regular surveys of the occurrence of mycotoxins, until now there are several countries in Africa where there has hardly been any survey carried out to investigate the incidence of mycotoxins on a national basis. The lack of mycotoxin surveys in Africa is undoubtedly linked to the limitations in analytical capabilities but also because it is not a high priority due to the many other development challenges or because the impact is not well understood.

> Stimulate innovative research

The effect of aflatoxin on animal health has so far been globally a lesser priority than its effect on human health. PAEPARD identified and is helping to bring stakeholders together to identify the research priorities and questions and do the research together. This has led to the formulation of research proposals around: mobile phone apps on awareness creation and moisture control; the use of binders in feed to reduce waste and give an incentive to farmers for contaminated crops which should be destroyed; biological control measures: in particular the use of antagonistic bio control agents in addition to the bio control agent 'aflasafe™'. Soil fertility is also an interesting entry point. The use of *Trichoderma* strains or extracts as bio-fertilizer or bio-agents also out-competes *Aspergius flavius* in the soil. While these issues may require sophisticated research, the developmental impact of such research may be considerable - if farmer organisations and agri-entrepreneurs are actively involved but also health workers and policy makers. This is why the PAEPARD type of platform is essential to address at national and regional levels the global challenge of aflatoxin.

> Funding multi stakeholder approaches

Controlling or reducing aflatoxin contamination in the agricultural value chains will have significant positive nutrition and wider health outcomes. This is exactly the type of subject matter that PAEPARD was conceptually designed to work on - a new breed of innovative Africa-EU agricultural research for development partnership that is intimately tied to health outcomes, actively involving researchers and research users and including the private sector and policy makers. According to PAEPARD experience of its consortia and users' led process groups, a new funding system based on well balanced public and private investments would generate well balanced public goods and profits that would make the research outcomes more relevant, applied and impactful. Depending less on public and competitive funds, such innovation platforms, clusters or incubators would have a chance to become more sustainable for addressing the next challenges.

The role of multi-stakeholder partnerships between Africa and Europe exemplified by the issue of aflatoxin contamination of food and feed

1. Evidence for a multi-stakeholder approach

For two decades now the problem of aflatoxin has been mainly confined to the research area. A meeting of experts in research and development in Bonn[1] demonstrated that all kinds of actors get mobilized to tackle the problem, but bridging research and development in this field is still challenging due to the complexity of the contamination sources at pre- and post-harvest levels.

Since 2010 **PAEPARD** has been promoting, through multi-stakeholder partnerships and brokerage between researchers, NGOs extensionists, farmers' organization representatives and actors of the private sector, innovation processes which create initiatives or add value to existing ones in various value chains. Bringing partners together has given them the opportunity to learn from each other, what others are doing and can do about aflatoxin contamination in maize, groundnut, dried fruits and livestock feed, and in this way create synergies and avoid duplication of efforts. In many cases, the existing gaps in addressing aflatoxin contamination in food and feed along the chain can be identified, which gives an opportunity to formulate strategies to address those gaps. Ways to develop solutions to contamination by aflatoxin can be identified faster and more efficiently.

Multi-stakeholder partnerships have added a considerable value to the existing initiatives by partners and actors in several value chains and across them. The coordinated **PAEPARD** support to aflatoxin-related research consortia has allowed for greater synergies and complementarities between a number of **PAEPARD**-supported consortia. It has also allowed PAEPARD to be in a stronger position to influence donors on funding.

2. The importance of the aflatoxin problem

Aflatoxins are very powerful, broad acting natural toxins produced as secondary metabolites by selected fungi (particularly *Aspergillus flavus*, *A. parasiticus* and *A. niger*) growing in dried, or drying foods and feeds such as grains and seeds, fruits and tubers. Since 2009 surveys on the aflatoxin contamination of maize have been carried out in different parts of Kenya. The results that have shown alarming levels of aflatoxin contamination of maize have been discussed with farmers and other stakeholders including the Kenya National Federation of Agricultural Producers, and all agreed that addressing the aflatoxin contamination of maize is a priority. Farmers and other stakeholders have also incurred big economic losses; for example in 2010 when 2.3 million 90-kg bags were declared unfit for food or feed due to aflatoxin contamination. Heavy mortalities have been caused through the outbreak of aflatoxicosis periodically. During the worst outbreak of aflatoxicosis in Kenya in 2004[2], 317 cases of poisoning were reported and 125 people died.

Mozambique Contaminated groundnut kernels. (Photo credit: ILRI)

[1] Expert meeting on 'Food Safety for Nutrition Security ', 01-02 October 2014, Berlin, Germany

[2] Emergency and Disaster Reports 2015, 2(3):1-45, http://dialnet.unirioja.es/descarga/articulo/5148276.pdf

A quarter of key food crops is contaminated by mycotoxins in Africa

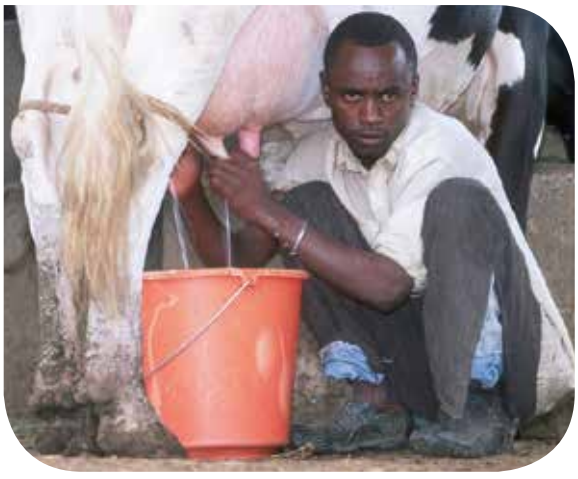
Dairy cattle, in general, can tolerate relatively high levels of aflatoxin in their feed. It has been hypothesized that the microbial population in the rumen is able to metabolize most mycotoxins including aflatoxin. However, some of the toxic metabolites can be excreted in milk and cause public health concern and impact on trade. Aflatoxin has been the most commonly occurring mycotoxin in feed and has the most significant impact on the dairy industry. The concentration of aflatoxin (M1) in milk is highly dependent upon dietary aflatoxin (B1) and the threat to humans makes aflatoxin in dairy feeds a constant concern. In Europe maximum levels for aflatoxin M1 have been set for consumable milk at 0.05 µg/kg (= 0.05 parts per billion or ppb).

Aflatoxin contamination of food and feed is a common problem for African countries that have deficiencies in their storage and post-harvest handling processes. Occasionally such contamination occurs also in Europe. The problem is acute in Western and Central Africa with maize and groundnut; and in East and Southern Africa with dairy products; because of (a) differences in production, storage and processing practices and (b) quality standards and testing procedures. Nestlé and Friesland Campina, amongst others, are re-evaluating their activities in the dairy sector in East Africa as they cannot guarantee their milk and milk products are aflatoxin free (note however that cheese contains much less aflatoxin M1). There is growing evidence supporting a link between stunting and aflatoxin levels in the body. East African governments are also concerned about reduced dairy sector development and effects on regional trade in meat and milk. Kenyan feed producers may claim they have reduced the toxicity level thanks to clay binders but this has not been verified by public research.

Because of the scale of the problem, which also affects European crops, the European Commission (EC) has funded a number of research projects to investigate several aspects related to toxic fungi and mycotoxins in food crops: the FP6 MYCO-GLOBE Specific Support Action (launched in October 2004), the FP7 MycoRed project which organised a number of international conferences in Africa (2008 Ghana, 2011 South Africa, 2010 Egypt), the FP7 MYCOHUNT project that developed rapid detection methods of mycotoxins in wheat, and the 6 consortia that submitted a proposal under the H2020-SFS-13-2015 call: *Biological contamination of crops and the food chain.* This recent call required a multi-actor approach, however, it focused on a long-term collaboration with China on food safety, and did not include Africa. The 1st African Symposium on Mycotoxicology - Reducing mycotoxins in African food and feed - was held in 2015, Livingstone, Zambia under the auspices of the International Society on Mycotoxicology (ISM), with the support of the Partnership for Aflatoxin Control in Africa (PACA) and from the European Union (through MycoRed).

During the European Development Days[1] Dr. Shenggen Fan - Director General of the International Food Policy Research Institute - estimated that the number of deaths due to agricultural generated diseases is 2 million persons every year. This includes the pre-harvest generated diseases (illnesses and mortality due to malpractices in fertilizer and pesticide use), post-harvest generated diseases (due to bad storage or transport) and food and feed contamination (impairing the health of consumers and animals). A complex contamination is due to mycotoxins.

However, the recently publicly released DevCo Action Plan about reducing the number of stunted children under five by 7 million by 2025[2] does not explicitly refer to the impact of aflatoxin on humans.



Kenya Youth milking in Machakos. (Photo credit: ILRI)

[1] European Development Days, 3-5 May 2015. Panel on small-scale farming and sustainable food systems.

[2] DevCo, Reducing the number of stunted children under five by 7 million by 2025 Capacity4Development, 13/07/2015.

3. When PAEPARD consortia address the issue

PAEPARD supports/facilitates three aflatoxin-related research consortia:

(a) Stemming aflatoxin pre- and post-harvest waste in the groundnut value chain in Malawi and Zambia;

(b) Developing strategies to reduce fungal toxins contamination for improved food sufficiency, nutrition and incomes along the maize value chain in the arid and semi-arid lands of Eastern Kenya; and

(c) Developing feed management protocols for dairy farmers in high rainfall areas in Kenya.

These consortia are led respectively by the Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN), the Kenya Agricultural & Livestock Research Organisation and the East African Farmers Federation (EAFF). The research project on groundnut in Zambia and Malawi has been directly funded since October 2014 through the **PAEPARD** competitive research fund (CRF) with an additional budget from the EC's Directorate-General for International Cooperation and Development.

Other **PAEPARD** supported consortia facing aflatoxin contamination issues may also influence the policy of the country when multi stakeholder consortia or innovation platforms take up the role of increasing the collaboration among all concerned actors. These **PAEPARD** consortia are: (i) Malawi-aquaculture: groundnut cake fish feed; (ii) Nigeria-chicken feed; (iii) Togo-peppers; (iv) Ghana-postharvest technologies; (v) Zimbabwe-goat dairy; (vi) Three consortia on soya (Benin, Togo, Uganda): soya beans are the base for many popular food items, from tofu, soy milk and cheese to breads, cereals and beverages that contain soy protein powder or other derivatives. When grown under certain conditions, the soya bean crop may become vulnerable to molds or other diseases which can have dangerous effects on a consumer health.

PAEPARD streamlined and synthesized its approach and has built up its credibility through greater awareness and knowledge about the research and non-research problems associated with aflatoxin contamination. This was not without its controversies. It however exemplifies very well the various individual strategies and the necessary concertation for a common level of information and joint actions.

Mozambique Drying maize traditional. (Photo credit: ILRI)

The EAFF is member of the PACA Steering Committee. The **PAEPARD** management represents EAFF in the Inter-Agency Donor Group (IADG) on pro-poor livestock research and development. A meeting in 2013 discussed the outcomes of the IADG East African dairy study - 'White Gold'. This offers the opportunity to give regular updates on on-going projects and link livestock research to both contaminated food and feed issues.

A positive development was the creation of an Agriculture and Rural Development Donors Group of Kenya on aflatoxin. This group - from November 2014 onwards - raised concern that there were various ongoing research projects on aflatoxin in Kenya whose results needed to be shared and discussed to inform the way forward.

While specific challenges or opportunities may have a definite lifespan, brokering is required for second order challenges such as developing linkages with fodder markets, cereal store keepers and health specialists. It became obvious that the brokerage could not be limited to research actors and development actors involved in aflatoxin but brokerage, positioning & profiling of EAFF in this field required crossing boundaries between agriculture, nutrition and health.

4. Research initiatives

During the 1st Symposium on African Mycotoxicology (Livingstone, Zambia, May 2015), several areas were suggested to address the mycotoxin problem in Africa:

- Raising awareness of all actors through education, information and knowledge sharing;

- Adopting good pre-harvest practices such as early harvesting, use of early and/or resistant varieties etc.;

- Adopting good post-harvest practices such as rapid drying of products to a safe moisture level, mechanical sorting and improved storage and transportation etc.;

- Developing infrastructures such as sanitation, improved storage structures etc.;

It is clear from this list that not all involve a technological research agenda; but where research is necessary, the strong involvement of the farmers' organizations, of the public authorities and the civil society is necessary for an impact on public health. Below is the most recent example of how research and development, public and private actors, were integrated in an initiative to reduce aflatoxin risk:

PAEPARD facilitated in April 2015 the proposal writing for the EC Horizon 2020 Call: H2020-ICT39-2015[1]. The write shop for this proposal was financed by the **PAEPARD** Innovation Fund (IF) and organised by the East African Farmer Forum, a partner of PAEPARD. Unfortunately it was not selected. The focus took a very interesting turn when the initial consortium of ICT experts from Sweden and Italy accepted the brokerage of **PAEPARD** and included the East African Farmer Organization, two African ICT labs (Living Labs) and the CGIAR Biosciences eastern and central Africa (BecA)-ILRI Hub. The consortium wanted to demonstrate how research data related to aflatoxin can be translated into modelling and hotspots identification for the benefit of a specific targeting of the beneficiaries by development actors and farmer organisations. Without being able to target the hot spots of aflatoxin (in Kenya and Tanzania initially), efforts to have an impact would be in vain. Once the hot spots are identified mobile phone apps on awareness creation and moisture control could be developed.

From this unfunded initiative several proposals are being produced, targeting not only a donor but also the enabling environment for adopting the innovation and enhancing chances of sustainability. The proposal can focus on the food safety (human health) or the food security (agriculture) aspects: the inter-sectoral approach, together with education, is essential. The multi-stakeholder partnership is not less crucial to develop the relevant ICT tools (apps related to storage, transport, weather forecast...) and related sensors (to monitor the moisture content) that will respond to the specific needs of information for reducing aflatoxin contamination along a given value chain (groundnut, maize, dried mangos ...). While the more technical information would be targeted at extension agents, NGOs, buyers, etc., a second layer of advisories would be targeted towards farmers, using simple messages, in local languages, to provide information on strategies to avoid or reduce aflatoxin. The third layer of information management is at the national governments and decision makers, public or private entities.

The proposal took a very interesting focus when the European experts accepted to include African partners

Other initiatives are planned using **PAEPARD** incentive funds, that gain from the information exchanged within the consortia and between the various innovation platforms (F&BKP in the Netherlands, PACA, UniBRAIN etc.). In particular, the combination of research areas on *Trichoderma* as biofertilizer and its potential use as biocontrol agent is strongly mobilizing the consortia led by the industry and by the farmers' organizations. It also highlights the need for a cross-cutting approach (based on pilot units of compost from organic wastes, for the production of biocontrol compounds such as *Trichoderma*, rhizobia or mycorrhiza) in synergy with the value-chain approach (application on legumes, cereals, or on perennial crops such as cocoa, coffee or tree fruits).

Kenya Sampling milk. (Photo credit: ILRI-Taishi Kayano)

5. Perspectives according to PAEPARD experience

New research areas to reduce aflatoxin risks are related to detection and information methods (as mentioned above), and to pre- and to post-harvest practices using binders and biological control agents.

Contaminated food or feed can be treated post-harvest in order to detoxify aflatoxin in the body so that it would present no more risk for human or animal health. Nixtamilisation is one option, but applying this approach at a large scale in Africa has not been researched yet. Nixtamalization refers to a process for the preparation of maize (corn), or other grain, in which the grain is soaked and cooked in an alkaline solution, usually limewater, and hulled. However, the detoxified products from nixtamalization can actually be reversed in the digestive system, thus reactivating the aflatoxin[1]. This may be the case with some of the biological binders as well, such as lactic acid bacteria. Other research questions regarding the binders, are: How do they bind mycotoxins under in vivo conditions? Are there local foods/binders that give protection? Have these been researched?

Biological control using microbial antagonist strategy has emerged as a promising approach for control of pre-harvest contamination of aflatoxins. The antagonist microorganisms include competitive atoxigenic strains of yeasts or bacteria, and symbiotic fungi (*Trichoderma* spp., *Beauveria* spp., mycorrhiza). In Africa, some microorganisms almost exclusively atoxigenic strains of *Aspergillus* spp. are already available as branded products. However, several challenges ranging from economic to environmental sustainability have not yet been addressed[2].

Beyond the lack of knowledge on aflatoxin control, **PAEPARD** has experienced: (i) the lack of coordination of the actors in order to focus the energies, skills and resources, (ii) the poor communication between research and non-research actors. On a positive note, when this is addressed it is easier to define and follow action plans. In another step, enabling the environment for a fruitful public-private partnership is a pre-requisite for long-term and sustainable innovation platforms: (iii) clear roles and duties are defined among partners, and (iv) relevant balance between public goods and profits, contribute to the spirit of entrepreneurship, the financial sustainability of the platform and the rapid application of innovations leading to positive impacts.

Drying groundnuts on tarps in Ghana. (Photo credit: PMIL)

A necessary joint combat to fight 2,000 death each day in Africa from food safety related problems

[1] Méndez Albores, J. A., Villa, G. A., Rio García, D., & Martinez, E. M. (2004). Aflatoxin detoxification achieved with Mexican traditional nixtamalization process (MTNP) is reversible. Journal of the Science of Food and Agriculture, 84(12), 1611-1614.

[2] Ehrlich, K. C., Moore, G. G., Mellon, J. E., & Bhatnagar, D. (2014). Challenges facing the biological control strategy for eliminating aflatoxin contamination. World Mycotoxin Journal, 8(2), 225-233.

Ehrlich, K. C. (2014). Non-aflatoxigenic Aspergillus flavus to prevent aflatoxin contamination in crops: advantages and limitations. Frontiers in microbiology, 5 :50.

Williams J. 2015. An OPED: appraisal of the competitive atoxigenic fungi technology (CAFT) for addressing aflatoxin contamination of foods and human aflatoxicosis in African developing countries. DOI: 10.13140/RG.2.1.1345.9041

PAEPARD

The Platform for Africa-Europe Partnership in Agricultural Research for Development (**PAEPARD**) is a 8-year project sponsored by the European Commission (80%) and partners' own contribution (20%).

It is coordinated by the Forum for Agricultural Research in Africa (**FARA**) since December 2009, and extended until end of 2017.

It aims at building joint African-European multi-stakeholder partnerships in agricultural research for development (**ARD**) contributing to achieving the Millennium Development Goals. On the European side, the partners are **AGRINATURA** (The European Alliance on Agriculture Knowledge for Development, coordinating the European partners), **COLEACP** (representing the private sector), **CSA** (representing the NGOs), **ICRA**, specialized in capacity building in ARD, and the Technical Centre for Agricultural and Rural Cooperation (**CTA**). On the African side and in addition to FARA, the partners are the Pan-African Farmers Forum (**PAFO**), the Regional Universities Forum for Capacity Building in Agriculture (**RUFORUM**) based in Kampala, and the Food Agriculture Natural Resources and Policy Analysis Network (**FANRPAN)** based in Pretoria. PAFO involves its members that are the Eastern Africa Farmers Federation (**EAFF**) based in Nairobi, the Réseaux des Organisations Paysannes et des Producteurs d'Afrique de l'Ouest (**ROPPA**) based in Ouagadougou, and the Plate-forme Régionale des Organisations Paysannes d'Afrique Centrale (**PROPAC**) based in Yaoundé. The Southern African Confederation of Agricultural Unions (**SACAU**) is an associate partner of **PAEPARD**.

REALISATION GRAPHIQUE : D. BONNET - PHOTOS : ILRI, PMIL - 10/2015

Disclaimer: «This project has been funded with the support of the European Union for the International Development and Cooperation General Directorate (DG-DevCo). This publication (communication) reflects the views only of the authors, and the European Union cannot be held responsible for any use which may be made of the information contained therein».

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