What are the risks associated with locust control operations?
During locust control campaigns there are two potential groups of risks, one for the human health (HH), and the other for the environment. In order to reduce the risks associated with locust control, it is necessary be aware of and understand the nature of those risks.

Human Health: who is at risk?
Insecticides used in locust control pose certain risk to HH of 1) those people who participate in control campaign, and 2) local populations. Field specialists who are directly involved in spraying operations tend to be the most exposed to insecticides, and thus also run the highest risk of being poisoned. This group includes pilots, drivers, pesticide loaders, transporters and applicators, flagmen, and survey and monitoring staff. Local populations, even though not directly involved in locust campaign, can also be exposed to insecticides by entering into sprayed areas.

Environment: what is at risk?
Negative impacts of insecticides applied in locust control programs include mortality of non-target organisms, including pollinators, locust natural enemies and other beneficial animals; mortality of fish; pesticide residues in crops, vegetables and fruits; pesticide residues in meat and milk. Soil and ground water also can be contaminated.

How to estimate the risk?
Risk is a function of the toxicity of the insecticide, the magnitude of exposure and its duration and could be expressed by the formula:

\[ \text{Risk} = \text{toxicity} \times \text{magnitude of exposure} \times \text{exposure duration}. \]

Toxicity can be both acute and chronic. Acute toxicity occurs after short-term exposure to the chemical. This is especially relevant for applicators, pesticide loaders and workers who are cleaning equipment or storage sites. Symptoms of acute intoxication normally show soon after exposure. Chronic toxicity shows much later after insecticide exposure, particularly in locust control staff who have been working for many years with insecticides. The more toxic an insecticide is (either acutely or chronically), the higher the risk will be of adverse effects. Magnitude of exposure (“the dose makes the poison”) in locust control depends on the dose rate of an insecticide, the number of treatments of the same area, the size of unsprayed buffer zones, the use of appropriate Personal Protective Equipment (PPE), and the quality of equipment calibration. Duration of exposure (time factor) is influenced by the persistence of the insecticide and the number of treatments of the same area, as well as by the duration that an applicator works with insecticides or the time he wears contaminated protective clothing.

How to reduce toxicity, magnitude of exposure and its duration?
Toxicity is an intrinsic quality of the insecticide, and strictly speaking, we cannot change it. What we can do in order to reduce the insecticide risk, is to choose and use lower-toxicity insecticides. To reduce the impact of pesticides use, it is important to calibrate and maintain
the spraying equipment on a regular basis, control the quality of spraying, use lower (but still effective and allowed by label) dose rates, avoid repeated treatments of the same areas, observe the buffer zones around water bodies and human settlements and ensure the use of appropriate PPE. If a barrier (or strip) treatment is possible, this reduction of the insecticide coverage will also reduce the magnitude of exposure. To reduce the duration of exposure, we should apply the best practices: appropriate use of PPE, respect of spraying parameters, buffer zones, etc., use of less persistent insecticides and again, avoid replicated treatments of the same area. Each of the chosen application strategies and techniques (items 9 and 10 of the provisional agenda) has its own advantages and disadvantages from human safety and environmental risk standpoint, and will be treated in more detail in the presentation. For example, during aerial treatments environmental concerns are usually higher than during ground treatments because of larger areas sprayed, higher probability of uncontrollable drift and contamination of ecologically sensitive areas such as wetlands, national parks, fisheries, bee-keeping areas, nature reserves etc., except if GPS and DGPS are part of the on board equipment of the aircraft. During ground treatments, human health concerns are usually higher because they involve more (and often inexperienced) staff and more opportunities for exposure. In all cases, using good pesticide application practices is a very important factor contributing to risk reduction and ensure the follow up and control of this good application practice in the field is the key success to reduce the pesticide use on the human health and environment.

Insecticide classification based on human health and environmental criteria
All insecticides used in locust control in CCA have undergone a strict process of national registration, which included not only anti-locust efficacy, but also human health and environmental impact criteria. Similarly, FAO considers these criteria as well as the World Health organization of the United Nations (WHO) hazard class of the considered active ingredient in its assessment of insecticides done by Pesticide Referee Group (PRG). Item 12 of the provisional agenda (Presentation of the latest PRG Report 2004) covers this question in detail.

Personal Protective Equipment (PPE)
PPE is the last line of defense against exposure to insecticides. But PPE will never provide absolute protection on its own. The PPE depends on the activity and, certainly, on the type of insecticides used. In general, the following PPE list is recommended as a minimum:
- cotton coveralls;
- long rubber (or PVC) gloves;
- rubber (or PVC) boots;
- cotton or hard hat;
- face shield, glasses or mask.
PPE should be comfortable to wear. Using heavy or impermeable coveralls, under the hot conditions often encountered in locust control in CCA and elsewhere, will most probably result in overheating. This is dangerous as it may reduce the concentration of applicators and result in errors. It can also cause heatstroke and dehydration. Lighter and more breathable coveralls tend to be more permeable and extra caution is needed during insecticide handling and spraying.

Education and regular training of staff working with insecticides is extremely important in enforcing the use of PPE. Training sessions on correct wearing of PPE as well as on accident reporting and first aid guidelines, should precede any pesticide manipulation in anti-locust campaign.

Campaign monitoring
Assessment of results of pesticide application is an essential part of any locust control campaign. Campaign monitoring consists in collection, analysis, interpretation and dissemination of data on the effectiveness and quality of treatment and effects of operational locust control on human health and environment. This includes control of all spraying parameters including dose rate, efficacy (i.e. locust mortality), reports on incidents and
effects on human health, impact on non-target organisms and the presence of insecticide residues in soil, plants, etc. The objective of this human health and environmental monitoring is to identify what goes right in operational locust control, and what can be improved. More detail on locust mortality assessment can be found in Working Paper for item 10 of provisional agenda.

**Withholding periods**
After insecticide treatment against locusts, a minimum time interval needs to be respected before humans or livestock re-enter the treated area, or before treated crops are harvested. This allows insecticide residues to diminish to acceptable levels and reduces the risk of exposure. Such minimum time intervals are generally called withholding periods. They are normally fixed by the regulatory agency responsible for pesticide registration, and are subsequently listed on the pesticide label. Locust control staff should inform the local population about these withholding periods and explain why it is important that they are respected. Clearly, control staff should set an example by strictly respecting these intervals.

**Cleaning up**
Empty insecticide drums or other containers are a health risk to humans and the environment because small amounts of insecticide will always remain in the containers. This is the case particularly for ULV formulations, which are very difficult to clean out. Contaminated or damaged personal PPE should be treated as chemical waste. It should be packed in sturdy plastic bags and returned to the locust control base for appropriate disposal. It should never be discarded at the control site since passers-by (especially children) may collect it and become contaminated. More information on cleaning up and pesticide management, including handling of empty containers, can be found in Working Paper for item 10 of provisional agenda.

**Monitoring human health**
*Occupational exposure.* Locust control staff run the highest risk of being exposed to, and possibly poisoned by, insecticides. It is therefore important that insecticide exposure is regularly monitored. A commonly used indicator for organophosphate absorption is the depression of acetylcholinesterase AChE (in red blood cells) and pseudocholinesterase (in blood plasma). This can be tested after taking a blood sample and subsequent analysis using a field test kit or in a specialized laboratory. If the level of AChE is 30% or more lower than the baseline, the exposure should stop and the staff should be withdrawn from work with insecticides.

**Monitoring impact on the environment**
The easiest approach to operational ecological monitoring consists in observations in treated areas. Observations are (mostly) qualitative assessments of the direct impact of a treatment, e.g. fish and crustacean kills, behavioral changes in birds, large bee mortality, etc. Even though ecological side-effects are not quantified, such observations are very important. Susceptible organisms can be identified for further study, and unexpected side-effects may indicate problems with the insecticide treatments. It is therefore always useful to take some time to walk through the treated plot and observe what happens. Most behavioral changes will occur fairly rapidly after spraying (i.e. 1 - 48 h after treatment). Mortality, however, may take longer, depending on the type of organism and the insecticide applied. The observer should attempt to record the level of sampling effort to make this type of assessment. Such assessments should be reported in FAO Standard Spray Monitoring Form adopted by CCA countries at Regional Consultation in 2009.

**Public awareness and information**
It is important to keep the public informed about possible environmental and health effects of insecticides, before, during and after locust control operations. This is to ensure that precautionary measures are taken whenever needed but also to reduce any misunderstandings that may exist about the risks of locust control.
Education in risk reduction
Analysis of safety and environmental precautions associated with locust control in CCA revealed that education of both locust control staff and local populations is urgently needed in all aspects of risk reduction, particularly in methodological approaches. Clear and comprehensive guidelines should be developed for pesticide handling and for human health and environmental monitoring.