SIMULATING KERNEL LOT SAMPLING: ESTIMATING THE EFFECT OF HETEROGENEITY ON THE DETECTION OF GMO CONTAMINATIONS

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Introduction

Guidelines defining kernel sampling strategies for quality and purity analyses have been provisionally adopted for the detection of genetically modified (GM) contamination in kernel lots. All these approaches include three assumptions:

- The sampling procedure is considered a single operational step, even though it comprises several independent actions;
- The statistical implications of the clustered sampling of kernels (increments) applied in practice to the lot are ignored;
- The distribution of GM material is assumed to be random, so that the binomial distribution can be used to calculate the precision of the estimate.

By contrast, we contend that these three assumptions present a major case for review.

Our objective is to assess the effects of both stratification and incremental sampling on the accuracy of GM contamination estimates in large kernel lots.

Sampling

The methodology adopted is based on a two-step modelling procedure:
1. lots with different levels of stratification (i.e. lot heterogeneity) are created.
2. the created lots are sampled.

This allows assessing different sampling strategies as a function of specific combinations of population characteristics and sampling parameters.

Results

Below, CVs associated to GM estimates for 2 levels of impurity are shown. As stratification increases, estimates stability decreases. Interestingly, the variability of GM estimates is not affected by the level of contamination.

% GM kernels	Increments sampled	Level of Stratification				
		73%	*36%*	*15%*	*7%*	*4%*
0.1%	10	21%	40%	76%	111%	150%
	20	13%	30%	60%	78%	111%
	50	10%	19%	33%	45%	72%
	100	7.8%	15%	22%	35%	53%
1%	10	19%	40%	76%	108%	151%
	20	15%	29%	49%	87%	118%
	50	9.4%	18%	27%	47%	70%
	100	6.4%	15%	18%	31%	57%

Reference

Paoletti, C., M. Donatelli, S. Kay, G. Van den Eede. 2002. Simulating kernel lot sampling: the effect of heterogeneity on the detection of GMO contaminations. *Seed Science and Technology* (in press).

KeSTE

In order to test various population structures and different sampling strategies, we developed a prototype program ***KeSTE***.

In ***KeSTE***, lot creation is based on three parameters:

1) Total number of kernels (lot size)

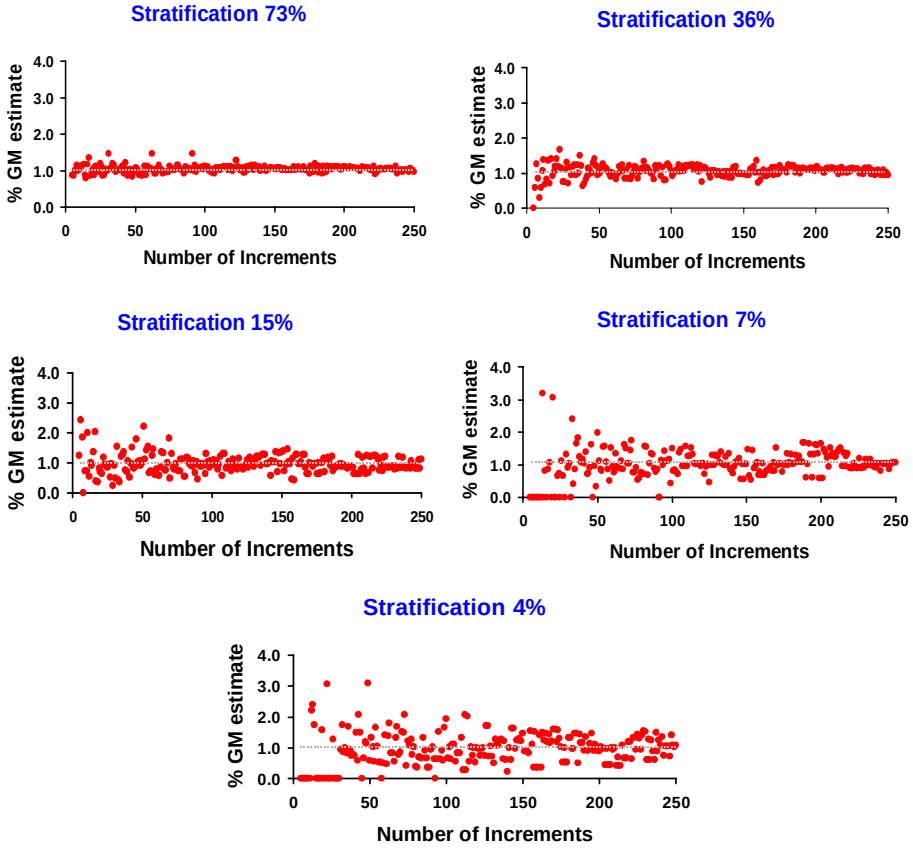
2) Percentage of GM kernels (contamination rate)

3) Level of stratification of GM kernels (lot heterogeneity): stratification can range from 100% (uniformity) to 1/N% (maximum heterogeneity: all GM kernels are located in a single unit).

Results are shown for lots with 10^7 kernels and 1% GM kernels.

Results

The effects of 5 levels of stratification on the accuracy of contamination estimates are shown. Even in case of modest stratification a large number of increments is needed to correctly estimate the true level of GM contamination (1% in the data shown). Moreover, as stratification increases, false-negatives (GM estimate = 0) become evident.



Conclusions

- Current sampling techniques, requiring the sampling of maximum 50 increments, are sensitive to non-uniform distribution of impurities, resulting in high probability of the wrong estimates and high likelihood of false-negative results.
- While the simulation of non-uniform distributions can be extended to deal with more complex scenarios of GM impurity (multiple sources, different strata densities, within-stratum GM kernel distribution modelling), these results issue a clear warning with respect to the unconditional acceptance of standardized sampling procedures in absence of the knowledge of GM material distribution in kernel lots.

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