**Report: Methodology and Defensibility of the Targeted Acreage Rebalancing Technique in label\_area\_deltas.py**

# Purpose

This method refines ACI-derived crop area distributions within each Rural Municipality (RM) to better align with MASC’s ground-truth acreage totals, without distorting total agricultural area. It is a final harmonization step between the ACI’s satellite classification and MASC’s observed data, ensuring that subsequent biomass modeling operates from compositionally realistic proportions at the RM level.

# Methodology

* Identification of Recipients: For each RM, crops where ACI acreage (aci\_acres) falls short of MASC acreage (masc\_acres) are identified as recipients. These represent crops that are under-classified by the satellite model.
* Donor Hierarchy: Surplus acreage (where ACI exceeds MASC) is drawn only from crops designated as flexible donors — Other crops, Pasture/forages, and Canola/rapeseed (as a tertiary donor). These classes are abundant, spatially diffuse, and more prone to over-classification in satellite data, making them defensible sources for limited area transfers.
* Reallocation Logic: Within each RM, deficits are topped up from the donor hierarchy in sequence. Acreage is subtracted from donor surpluses and added to recipient deficits until either all deficits are filled, or available donor surpluses are exhausted. This preserves total RM acreage and RM-level compositional balance.
* Auditability: Each adjustment is logged in a CSV report showing pre- and post-allocation acreages and the source of transferred area (taken\_from\_other, taken\_from\_pasture, taken\_from\_canola). This enables transparent review of every rebalanced unit.

# Defensibility

* Ground-Truth Alignment: The reallocation ensures that total crop area per RM matches the distribution MASC reports, improving fidelity of biomass estimates while maintaining physical area conservation.
* Bias Reduction: Satellite models tend to over-classify dominant crops and under-represent smaller or mixed classes. This method corrects those imbalances statistically rather than heuristically.
* Conservation Principle: Unlike resampling or reclassification, this technique does not introduce new crop pixels or change the total number of agricultural pixels. It simply reweights the composition of existing ones, maintaining internal consistency.
* Spatial Neutrality: The method deliberately avoids deciding where within an RM a reclassified crop should appear. It adjusts only the statistical proportions that downstream yield and biomass rasters will honor, ensuring interpretability.

# Limitations

* The process does not determine spatial placement of under-represented crops; it only adjusts aggregate proportions.
* If both MASC and ACI mischaracterize a crop’s spatial pattern, the imbalance correction will not fix that underlying issue.
* The assumption that donor crops are more flexible is reasonable but empirical validation should continue in future phases.

# Outcome

This reallocation step creates an internally consistent dataset that preserves total agricultural extent while aligning crop proportions with field-verified ground truth. When incorporated into pixel-level yield or biomass rasters, it will improve per-unit-area realism and reduce systematic bias, without introducing artificial data or arbitrary spatial corrections.