Back in the numbers game: High throughput phenotyping of biomass yield in perennial forage crops with multiple harvests

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Crop breeding relies on the numbers game. The higher the number of locations and entries evaluated, the higher the probability of developing superior cultivars. One major challenge facing breeders of perennial cool season forage crops is the number of biomass harvests per season. In regions with mild winters, alfalfa is harvested every four weeks, six to seven times a year. This creates an operational bottleneck limiting the number of entries and testing locations. Substantial investments were made in the development of automated solutions for precision Ag for row crops. The adoption of these platforms to forage crops rests on their accuracy in estimating biomass yield and cost-effectiveness. This work focused on evaluating the sensitivity of popular unmanned aerial vehicles (UAVs) and imaging strategies for optimal real-time biomass estimates in perennial forage crops. Experimental plots consisting of single plants, row plots, and sward plots were used for a hybrid data collection approach including direct measurements and remote sensing. UAV platforms equipped with a 42-megapixel RGB camera (Sony Alpha 7Rii), a five-band multispectral system (MicaSense RedEdge MX), a hyperspectral sensor (Resonon-Pika L), and a LiDAR (LiDARUSA Revolution 120) were tested. Images were used to generate 3D canopy models of vegetation in the field and to compute morphometric and spectral indices descriptive of vegetation coverage, health and vigor. Harvested biomass yield was used to validate the values derived from UAVs. Preliminary results suggest that the simple red-green vegetation index may be sufficient to give a reliable estimate of biomass yield.