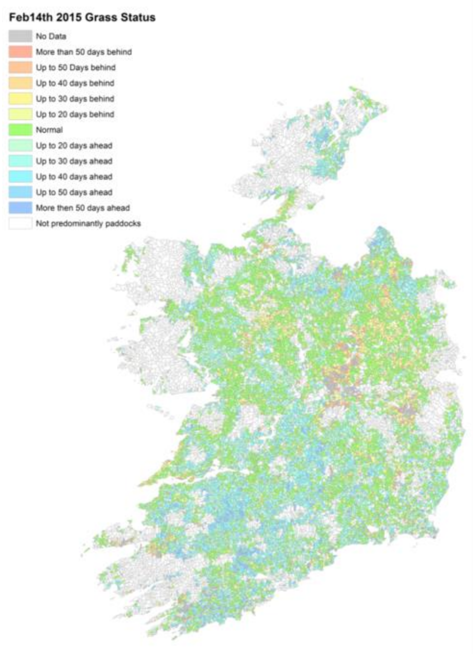
Project number: 6207
Funding source: Teagasc

Date: Jan, 2017
Project dates: Sept 2012-Sept 2016

Use of Satellite Technology in understanding farming conditions



Key external stakeholders:

Dairy Industry, Dairy Farmers, Beef Farmers, Policy Makers

Practical implications for stakeholders:

With a good understanding of grass growth performance as captured in satellite imagery, the interaction of the farmer with the environment when making decisions can be examined: This is a significant move toward satellite based precision agriculture techniques supporting Irish grass based enterprises.

Main results:

- A grass growth progress online tool launched, giving frequent updates of grass growth status compared to normal in spring
- Dairy farmer response to current grass cover and soil conditions when making turn-out decisions is analysed and farmers are found to respond with only 50% efficiency to changes form "normal" conditions.

Opportunity / Benefit:

Farmers and advisors can use the online maps of grass growth progress in spring to see how local conditions are deviating from normal, allowing them to plan for turn-out and other decisions.

This work shows how standard econometric models can incorporate real-time remote sensing data. This means that for the first time conditions on the ground during the growing season can be incorporated into agri-economic models in Ireland

Collaborating Institutions:

UCC

Teagasc project team: Dr. Stuart Green (PI)

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1. Project background:

Grass is the most common landcover in Ireland and covers a bigger percentage (52%) of the country than any other in Europe. Grass is the most important fodder crop and is the foundation of the most important indigenous industry, agriculture. Yet knowledge of its distribution, performance and yield is scant. How grass can be grown and utilised to a high degree to ensure profit on the farm is well known, but how grass nationally, on a farm by farm, year by year basis, is actually managed is not. Remote sensing from satellites can fill some of this information gap.

2. Questions addressed by the project:

Grassland farmers face daily challenges in trying to manage best practice in measurement of grass, calculating feed demand, grass-budgeting and forward planning. In part to address this, the questions to be answered in the research are:

- Can current grass growing conditions be assessed by satellite, for example how well is the grass growing now compared to previous years?
- Can management decisions be predicted from observed conditions, for example how efficiently are farmers using the grass that's growing?

3. The experimental studies:

The use of time series of satellite observations for environmental monitoring is well established but under-used in a managed grassland context. Grass growth dominates over grass management early in the growing season, and thus a 250m scale characterization of early spring vegetation growth from 2003-2012, based on MODIS satellite normalized difference vegetation index (NDVI) products, was constructed. The average rate of growth is determined as a simple linear model for each pixel, using only the highest quality data for the period. This provides a typical spring grass growth trend value for entire country with a resolution of 6 ha.

The 2012/2013 "Irish fodder crisis", when animals were unable to be released from winter housing because of poor weather, demonstrated a need for a system to estimate current growing conditions. Using the spring growth model constructed for estimating stocking density, a new style of grass growth progress anomaly map in the time-domain was developed. Using the developed satellite dataset and 12 years of ground climate station data in Ireland, NDVI was modelled against time as a proxy for grass growth. This model is the reference for estimating current seasonal progress of grass growth against a ten year average. The model is developed to estimate Seasonal Progress Anomalies in the Time domain (SPAT), giving a result in terms of "days behind" and "days ahead" of the 10 year average.

With a good understanding of grass performance as captured in satellite imagery, the interaction of the farmer with the environment when making decisions could be examined. The decisions on when to turn out cattle, the turn out date (TOD) from winter housing to spring grazing, is an important one on Irish dairy farms. To examine the relationship of TOD to growing conditions, the National Farm Survey (NFS) of Ireland database was geocoded and the data on turn out dates from 199 farms across Ireland over five years was used. The average TOD was 1st March, and the average, over the five years, on farm difference between the earliest and latest date was 25 days. A fixed effects linear panel data model was employed to explore the association between TOD and growing conditions.

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4. Main results:

SPAT estimates for 2012 and 2013 are compared to ground based estimates from 30 climate stations and have a correlation coefficient of 0.897 and RMSE of 15 days. Thus the method can successfully map current grass growth trends compared to the average and present this information to the farmer in simple everyday language. This is believed to be the first validated growth anomaly service for intensive European grasslands.

The environmental variables used in the TOD analysis account for 38% of the variance in the turn out dates on farms nationwide.

- National seasonal conditions dominate over local variation. Every 100 mm extra rain in spring means TOD is a day later and every extra dry day leads to turn out being half a day earlier.
- Location and soil type are the dominant factors affecting average turn out dates; a well-drained soil makes TOD 2.5 days earlier compared to a poorly drained soil and TOD gets a day later for every 16 km north from the south coast.
- For every week earlier grass grows in spring, as indicated in the satellite data, farmers gain 3.7 days in grazing season but ignore the 3.3 days of growth that could have been used. Thus it seems that farmers are "caught on the hop" in good years and do not get cattle out as early as possible.

5. Opportunity/Benefit:

In the absence of routine grass measurement by farmers, and the apparent reluctance of farmers to engage with farm management software, there is considerable scope for the development of automated mobile EO services to help farmers with decision making in pasture management and to present the information in such a way that it can be absorbed in an *ad hoc* way into existing farm management paradigms. The work presented here forms the basis of estimates of national fodder harvest and an early warning system for fodder shortages. The relative low level of variance due to local environmental conditions in deciding turn out date and the strong geographic trends and national trends suggest that the current calendar focused targets for encouraging earlier turn out date targets nationally may need to be adapted on a regional basis.

6. Dissemination:

Maps of current grass conditions are available each spring (from Mid Feb to Mid April) on http://teagasc.maps.arcgis.com

Green, S., Cawkwell, F., & Dwyer, E. (2016). Cattle stocking rates estimated in temperate intensive grasslands with a spring growth model derived from MODIS NDVI time-series. *International .Journal Applied Earth Observation & Geoinformation, 52*(October 2016), 166–174.

Popular publications:

Green, S., Cawkwell, F., & Ali, I (2013). Mapping Grass from Space. *T-research*, Spring 2013.

7. Compiled by: Stuart Green

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