Comparison of Growth Curves and Seasonality Parameters of Main Field Crops in a High Elevation Mountain Area based on TIMESAT Program

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Time series Normalized Difference Vegetation Index (NDVI) has been shown to provide useful data that can be applied to study vegetable phenologies and crop calendars, and much research has been conducted with it in the main agricultural regions of China. However, few studies using NDVI have been conducted in the Qinghai-Tibet Plateau where agriculture is often limited in the valley and piedmont areas. From the view of agricultural diversity and food security, agriculture (especially grain production) is still very important in this area and thus research is needed. Here we conducted research in a small watershed (Figure 1) in the upper stream of the Huangshui River (which is the largest tributary of the Upper Yellow River and also the main grain production area of Qinghai Province), with the goal of testing the feasibility of extracting seasonality parameters using Landsat Thematic Mapper (TM) images and the TIMESAT Program, and also determining the potential NDVI criteria to discriminate different crop types. Crops in this area are spring wheat, highland barley, rape, potato and broad bean.

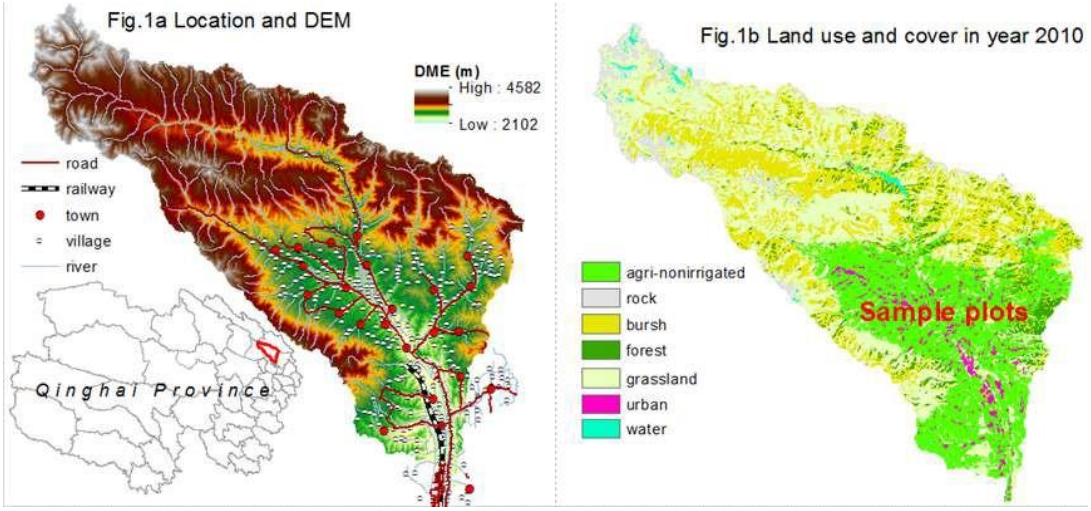

Figure 1. Base maps of the research area.

In this study we first collected field samples of crops in 2013 while ensuring each crop had at least 3 samples of a minimum area of 0.5 hm^2 (equal to 6 pixels of 30 m resolution). Second, we collected quality TM image sequences from Landsat8, to create time-series NDVI data sets involving 2 complete calendar years (Figure 2). Third, we extracted seasonal parameters for each crop, fitted using three different methods (SG - adaptive Savitzky-Golay filter, AG – Asymmetric Gaussian function filter, and DL – Double Logistic function filter) incorporated into the TIMESAT program, along with the corresponding crop calendars (Figure 3). We verified the research accuracy based on random samples selected from a land use map, and interpreted parameters of each crop based on local agricultural practices.

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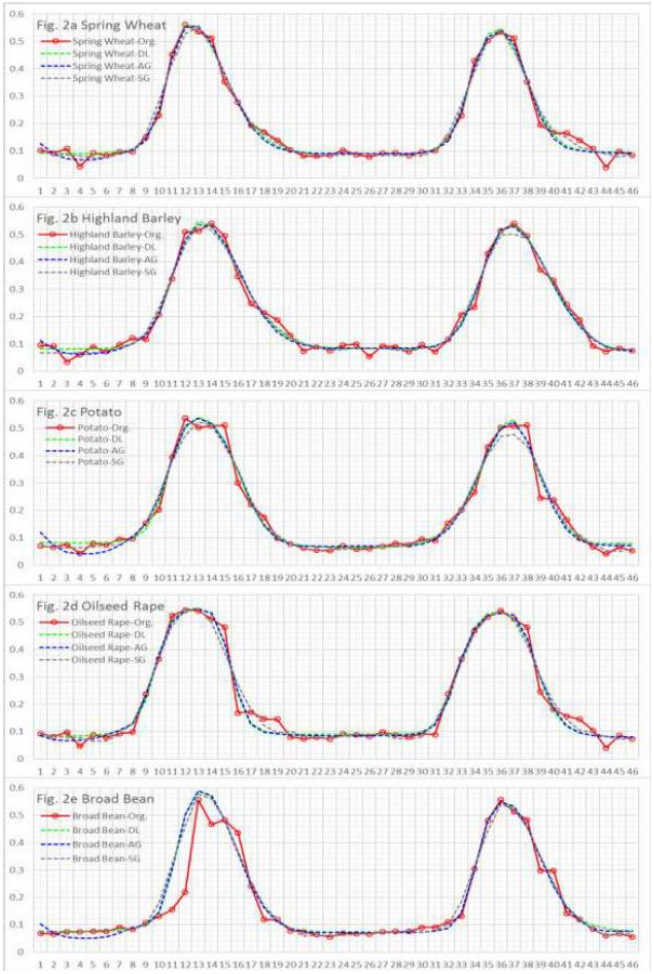
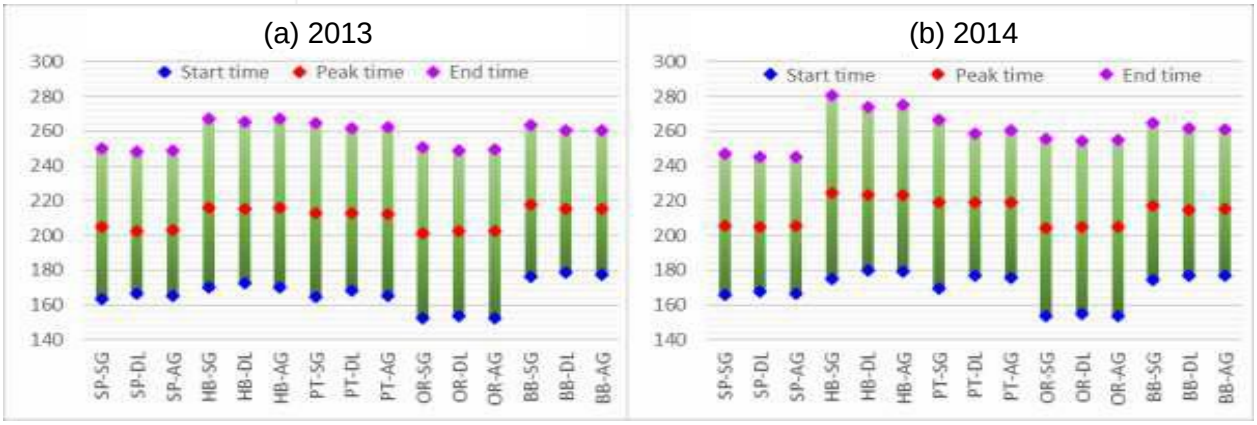


Figure 2. Crop profiles of original NDVI data and fitted curves for 2013-2014.

For crops like spring wheat, highland barley, and oilseed rape with obvious single growth peaks and symmetric distributions during the growing season (Figure 2) the DL filter had the highest consistency in both curve shape and infection points. The AG filter also had good performance for those crops, but had some small deviations for the onset and dormancy points when the adjacent raw NDVIs were waived; however this could be improved by using smoother NDVI series. The SG filter showed poorer performance, such as the drag-down effects at the peak points and wavering effects at onset and dormancy points. Filters like DL and AG are recommended for high elevations (above 2000 m) and complex topology (by which croplands are often constrained in river valleys and low slope hilly areas), or where noisy NDVIs have been contaminated by clouds/snow/smog or other factors, because DL and AG are less sensitive to noisy NDVIs.

Crop calendars (Figure 3), besides implying specific time information for rotations of different crops (like intercropping short season vegetables before the seasonal start time of regular field crops), can also provide information for irrigation scheduling. Requirements for irrigation still vary annually because of weather, climate change, and human disturbance, thus further research is needed.



Notes: Crops are: SP-spring wheat, HB-highland barley, PT-potato, OR-oilseed rape, BB-broad bean. NDVI filters are: SG- Savitzky-Golay, DL-Double Logistic, AG- Asymmetric Gaussian.

Figure 3. Crop calendars for 2013(a) and 2014(b) derived from TIMESAT program.