Mapping Rice Fallow Areas for Short Season Grain Legumes
Intensification in South Asia using MODIS 250m Time-Series Data

ABSTRACT: The goal of this study was to map irrigated and irrigated-rice-fallow cropland areas across South Asia using MODIS 250m time-series for intensifying short season grain legumes such as chickpea. The suitability of irrigated and irrigated rice-fallow croplands for grain legume cultivation across South Asia were defined as areas that were identified as: (a) rice during the monsoon season, (b) fallow during the rabi season, and (c) low water-consuming grain legumes during rabi season. Existing irrigated or rainfed croplands are not considered suitable for grain legumes within the context of this study, because the moisture demand of these crops is too high for the rabi season. The study analyzed moderate-resolution imaging spectroradiometer (MODIS) 16-day 250 meter normalized difference vegetation index time-series data acquired for the period June 2010 to May 2011 using spectral matching techniques. Accuracy was evaluated based on independent ground survey data and compared with available sub-national level statistics. The accuracies of the cropland fallow classes were between 75-82%. The analysis estimated approximately 22.3 million ha of suitable rice fallow areas in South Asia. These areas can be targeted by decision-makers for sustainable intensification of short duration grain legumes.

INTRODUCTION - Cereal grains (e.g., rice, wheat) are most extensively cultivated crops in South Asia. Vast extent of these croplands where grain legumes are grown during Kharif (June-October) season, are left fallow during the Rabi (November-February), and/or the Summer (March-May) due to insufficient water during these seasons to grow water demanding cereal crops. However, far less water demanding grain legumes (e.g., Chickpea) can be grown during Rabi and/or summer seasons in these fallows. Such a measure will help farmers supplement their income, increase food security, and enrich diverse nutritional demand of increasingly richer South Asian population.

RESULTS - Rice fallows were mapped in South Asia using NDVI based temporal profiles, phenological signatures (Fig. 1) and a land use map (Fig. 2) for 2014-15. Almost all of the intermixing or misclassification was between various rainfed rice classes.

Fig. 1: Classic case of rainfed rabi fallow. A model of vegetation phenology and transition dates, as in equation (1). Tmin defines the beginning of the time series, Tm is onset of greenness, Td0 is beginning of development stage, To is onset of senescence, and Tm is harvesting of senescence. p and q are the inflection points. Figure shows the progression of class 05. Rainfed, single crop during kharif (June-October), fallow during rabi (November-February), and fallow during summer (March-May) (Figure 2). In this study we want to map rice croplands areas (either in kharif or summer) that are left fallow during rabi.

Fig. 2: Spatial distribution of rice-systems and rice-fallows (rabi-fallows)


MATERIALS AND METHODS -

Datasets:

Satellite imagery: MODIS-250m, 16-day reflectance composites were used to derive Normalized Difference Vegetation Index (NDVI), Land Surface Water Index (LSWI) and the NDVI Monthly Maximum Value Composites (NDVI-MVC) for the year 2014-15.

Extensive ground survey information: Ground information was collected during different seasons for two distinct purposes, on land use/land cover including irrigation source, crop intensity and crop extent. The first set of field points 996 (132 +361) locations were collected during October 11-20, 2014 for mapping cropland areas and second set of ground dataset (402 (131 +467) locations) were collected during January 15-30, 2014 for validation.

Methods:
The NDVI plots are ideal for understanding the changes within the period and during cropping seasons and between classes and exhibits the length of growing period. Temporal NDVI signature clearly elicits the planting time, peak growth and harvest stage in Figure 1. Detailed methods and approaches were explained in Gumma et al 2016

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NDVI = \frac{k}{1 + \exp(-c(d - p))} - \frac{k \times \exp(-c(d - q))}{1 + \exp(-c(d - q))}
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(1)

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