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A CASE STUDY :

Identification of rice fallows using remote sensing techniques: A case study in Telangana

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SUMMARY : Land use of country or a region is dependent on available natural resources and determines the economic activities of that region. Since ages man has explored different ways to bring the limited land to the productive use resulting in tremendous pressure on land. Contribution of land towards agriculture output is more than any other activity. About 40.95% of the total geographical area is utilized for agriculture use. The cropping intensity (CI, the ratio of gross cropped area to net cropped area) is one of the indicators for assessing efficiency of agriculture sector. Cropping intensity is poor in Telangana which is at1.27 during 2013-14.Apart from this, doubling of farmers income is being seriously considered by NitiAayog/ Government of India and increase in CI is identified as an important factor. In view of the above context an attempt has been made to identify and study the existing crop fallows in the Pulkalmandal of Sangareddy district of Telangana during post *Rabi* 2016 and 2017. Sentine l 2 satellite data is used to assess post *Rabi* crop fallow lands and suggest suitable cropping patterns for increasing the net income to the farmers. The study brings out the fact that on an average 66.25% area is left fallow after harvest of rice. As the area is closer to Manjeera river, potential exists for their utilization for cultivation of millets, legumes or forages. Suitable cultivars, technological interventions and research and development efforts needed are discussed.

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BACKGROUND AND OBJECTIVES

Around 75% of the Telangana state population depends on the agriculture income which constitutes 30% of the total state income. Stress on agriculture sectoris on rise due to as high operating cost of irrigation and increase in expenses on agriculture inputs which has resulted in reduction of land under agriculture over the last 50 years. Growth in population, need for the increasing in frastructure facilities, transformation of rural to urban settlements have transformed the land use change from agriculture to non-farm resulting in fallow lands. Fallow lands are the lands which was used for cultivation but is temporarily out of cultivation. Current fallow and fallow other than current fallow are the two types of fallow lands. Fallow of one year is called 'current fallow' while that of 2 to 5 years is classified as 'fallow other than current fallow'.

The rice fallows offer good scope for crop intensification, generating income and employment. Out of 15 million ha of rice fallows in south Asia, India accounts for 79% that are spread in the states of Andhra Pradesh, Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, West Bengal and Uttar Pradesh (Subbarao *et al.*, 2001). Andhra Pradesh has 11.5% of *Kharif* rice area as rice fallow and is spread in the districts of Krishna, Guntur, East Godavari, West Godavari, Srikakulum, Nellore and Prakasham (NAAS, 2013). Utilization of rice fallows for growing millets and pulses is being increasingly taken up in Andhra Pradesh. Similar pattern can be explored in the state of Telangana. In Telangana, around 12.50% of total cultivated areais under current fallow lands (14.01 lakh hectares). Paddy is the major food crop of the Telangana State. Out of the total cultivableland, around 26.26 % land is under paddy cultivation which shows the importance of identification of rice fallows.Other important crops grown are maize, *jowar*,red gram, green gram, bengal gram, groundnut,soya bean, mango, cotton, chillies, sugarcane etc.

The negative impact of change of agriculture lands to fallow lands results in decline in food production and increase in farmer poverty. In view of the above, there is a need to reduce the extent and frequency of fallow land in order to increase agricultural productionby identify the existing crop fallows. Suggesting a suitable crop for fallow lands will result in increase of net income of the farmers. A case study was taken up in Pulkalmandal, Sangareddy district of Telangana. To achieve this objective, time series high-resolution Sentinel 2 satellite data is used to suggest suitable cropping patterns for fallow as well as rice fallow lands. European space Agency (EPA) has developed and launched Sentinel-2 satellite in the year June 2015. Sentinel-2 satellite consists of Multispectral Imager (MSI) 13 spectral bands out of which four bands at 10 m, six bands at 20 m and three bands at 60 m spatial resolution.

RESOURCES AND METHODS

Study area :

Study was conducted in Pulkalmandal of Sangareddy district of Telangana state (Fig. A). It is located by the Manjeera river, 65 kilometers from Hyderabad city. Pulkalmandal covers an area of 242 sq kmand lies at an elevation of 632 m above sea level. The center coordinates of the study area are 17°43’49" N - 78°01’51" E. In the study area, 20% is occupied by Manjeera river which is a tributary of Godavari river originating from Gaukhadi Village, Beed district in Karnataka state. The Singur Reservoir situated in Pulkalmandal was opened for public in 1989 for the purpose of irrigation and hydro electric power generation. It is built on Manjeera River which is also a main drinking water

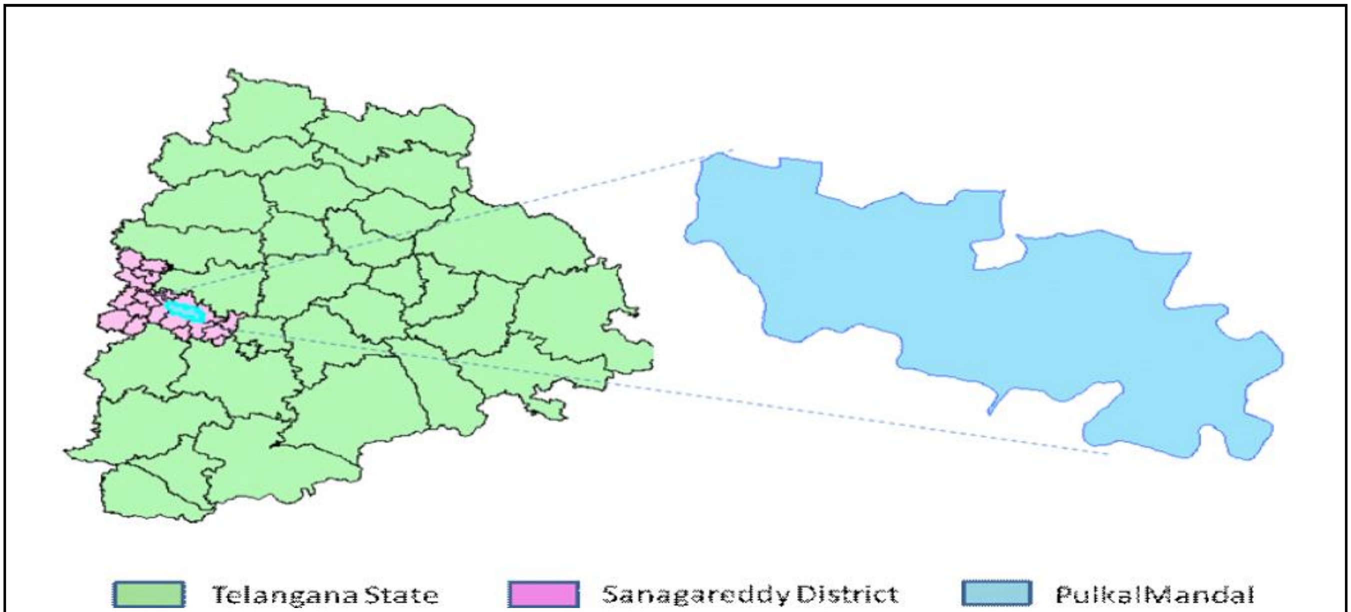

Fig. A : Location of the study area

source for the Medak and Nizamabad districts as well as the adjoining twin cities of Hyderabad and Secunderabad. Manjeera river is also serving the needs of Bidar city.

Having the locational advantage of reservoir, paddy is grown as the main crop in the mandal. Sentinel 2 multi spectral bands were used with observations acquired during January 2016, May 2016, January 2017 and May 2017, respectively. The Sentinel-2 images are shown in Fig B. From January 2016 to May 2017, there were several changes in crop land area, especially paddy. Apart from the satellite data analysis secondary data has been collected from Bureau of Economics and Statistics related to crops grown, land use land cover and irrigation.

While there is a long history of mapping rice with satellite data (Frolking *et al.*, 2002; Hukeand Huke, 1997; Knox *et al.*, 2000; Le Toan *et al.*, 1997; Liew *et al.*, 1998; Ribbesand Le Toan, 1999 and Yang *et al*., 2008), optical remote sensing efforts have shown particular promise. Pixel-based based analysis has been done using bothun supervised and supervised classifications. Sentinel 2 images were downloaded from USGS website. Sentinel 2for the post *Rabi* has been analyzed for two years (2016 and 2017) during the month of May as harvesting has been completed in most of the paddy fields. To know the extent of paddy cultivation in the study area, January month images has been analyzed for years 2016 and 2017. As the objective of the study is to bring out the rice fallow lands in the study area results of unsupervised classification has been used to classify the raster pixels based on the DN value it contains. To perform the unsupervised classification ISODATA algorithm technique has been used which has resulted in creation of unlabeled clusters or classes in the satellite image (Fig B).

In order to ensure the accuracy of the results, unsupervised classification method was used to determine certain number of classes in study area. After determining the class number, supervised classification was done with maximum likelihood analysis applied to all original and created images. Supervised classification is well known as controlled classification. Field work has been done to cross check the pixel categorization process by analyzing the high resolution images, photography and maps and local knowledge.

Primary survey has been done in the study area to know local practices such as paddy transplantation and harvesting timings during the study period as well. At the same time, secondary data has been collected from Bureau of Economics and Statistics, Telangana related to cropping pattern for last 5 years. The accuracy of the pixel based classification was evaluated using overall accuracy, using the validation samples and with Google earth. It is observed from the secondary data that the study area has get normal and above normal rainfall only during the months of September, November, October and December 2016. As a result of late transplantation, area under paddy has come down from 1165 ha (2016) to 1086 ha during 2017.

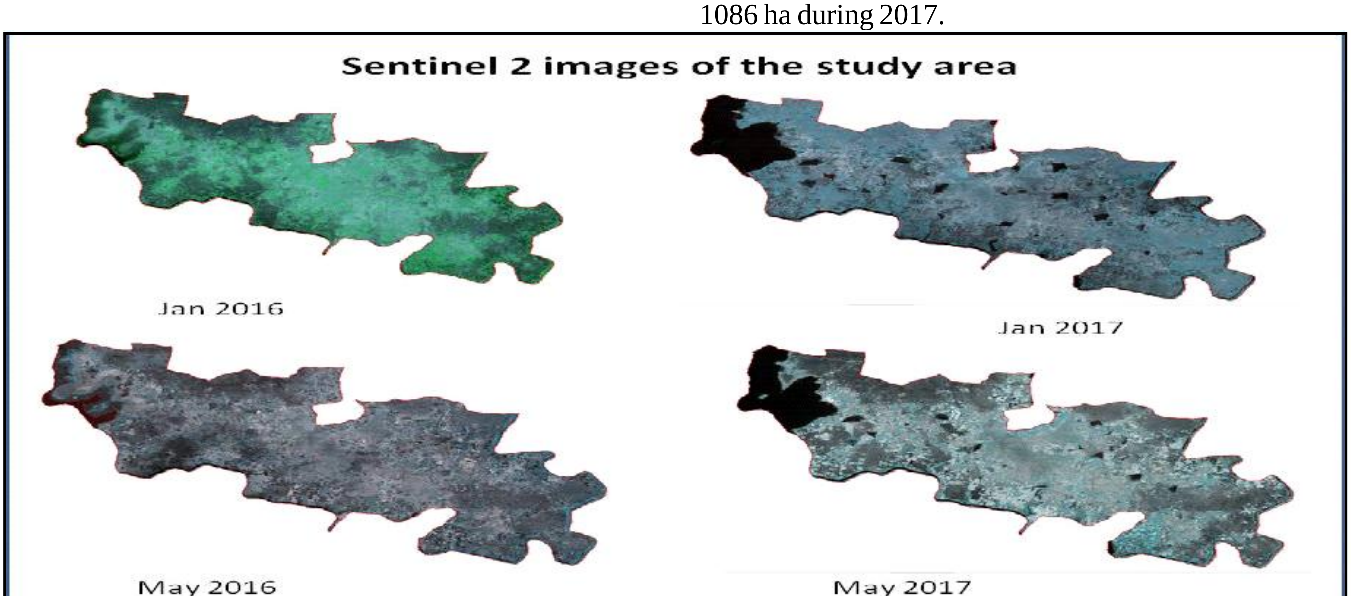

Fig. B : Sentinel 2 satellite images of the study area during different time period

OBSERVATIONS AND ANALYSIS

A rice fallow refers to the rice area that is not under cultivation during the subsequent season. The fallowing is due to water stress or water logging and lack of appropriate cultivars for late plantings. The study was conducted in Pulkalmandal during January to May 2016 and 2017. The rice is harvested during January-February and the land is left fallow. Hence, the area under rice, other crops and fallow is estimated using satellite data during January and May. During January 2016, 1165 hectares of area was under paddy cultivation while 59.12 ha were left fallow. However, during May, the fallow area increased to 783.87 ha. The area under paddy cultivation reduced to 1086 ha during 2017. However, the area under other crops increased reducing the fallow land to 89 ha. During May 2017, the area under paddy was restricted to 328 ha while there was an increase in fallow area to 804.4 ha (Table 1). On an average, 794.2 ha of rice fallows are available in the study area.

From the above data, it can be clearly seen that the fallow land increased after rice harvest and was unutilized. The residual moisture left in the soil at the time of rice harvest is often sufficient to raise short-season crops. Further, by use of short-duration and high-yielding varieties of rice allowing vacating fields earlier, the rice fallows can be converted into productive lands. Sorghum in rice-fallows (Guntur district in coastal Andhra Pradesh) had the highest productivity (6.9 t /ha in 2014-15) in the country. Sorghum in rice fallows in coastal Andhra Pradesh, especially in Guntur and adjoining districts is gaining popularity among the farmers and the crop is exclusively cultivated in rice fallows under zero tillage condition (Mishra *et al.*, 2011). It is now grown in more than 14,000 ha area in rice-fallows with an average productivity of 6.9 t/ha (Chapke *et al.*, 2017). Similar studies can be taken up on trial basis in Telangana also. However, the Telangana region requires short duration, drought tolerant crops due to prevailing climatic and edaphic factors.

Introduction of millets such as pearl millet and sorghum, oilseed such as ground nut, pulses such as

Table 1: Analysis results from sentinel 2 images

Period	*Rabi* sown area (ha)	Other crops (ha)	Paddy (ha)	Rice fallow (ha)
Jan-17	5982.00	4896.00	1086.00	89.00
May-17	1142.00	814.00	328.00	804.44
Jan-16	6129.00	4964.00	1165.00	59.12
May-16	1288.00	1072.00	216.00	783.87

Table 2 : Cultivars suitable for cultivation in rice fallows

Crop	Cultivar
Urdbean	LBG 17, LBG602, LBG 623, LBG-402, LBG-611,LBG-22, LBG-648, LBG-685, LBG-645, LBG-709 and LBG-752
Mungbean	Pusa 9072, NARM-1,NARM -2,NARM -18, LGG-460, LGG-410, LGG-450,LGG-407 andIM 96-3
Groundnut	Kadiri 4, Kadiri 6,TAG 24, Greshma, Rohini, Tripura 4 and Narayani
Pearl millet	86M64, Nandi 64, ICMV 221, ICTP 8203, Raj171
Sorghum	CSH 16, CSH 23, Mahalaxmi 296
Forage	Forage sorghum (CSH 24MF), Pillipesara

Table 3: Major technological interventions for improving productivity of crops grown in rice fallows

Issues	Interventions
Non-availability of appropriate cultivars	Development of drought tolerant, high yielding cultivars
Poor crop stand and establishment	Formulation of machinery
Diseases and pests	Development of IPM modules
Weed management	Post-emergence herbicides like Quizalofop ethyl and Imazethapyr
Nutrient management	Foliar spray of urea/DAP to supplement N and P; Mo, B, Zn as seed pallets
Terminal moisture/heat stress	Residue mulching

mungbean, urdbean, cluster bean and lablab bean etc. can be taken up. The cultivars suitable for cultivation is given in Table 2. However, there is a need to test and/or breed for specific growing condition.

The major constraints such as biotic and abiotic stresses, poor crop management practices, lack of awareness about modern methods of cultivation including quality seed of high yielding varieties and integrated pest management, poor linkage to market and government support price policies and socio-economic problems like stray cattle etc. were observed in rice fallows of Andhra Pradesh (Ali and Kumar, 2009). Development of package of practices and other interventions are desired (Table 3).

Research and development issues:

Crop choice:

Finger millet grown on rice fallows showed slow initial growth, favoured heavy weed infestation and in turn drastic reduction in grain yields (Triveni *et al.*, 2017). Hence, suitable crops should be selected for the region starting with pearl millet and mungbean on trial basis.

Mapping of rice fallows:

Though an effort to trace rice fallows are made in this paper, there is a need for disaggregated mapping of rice fallows with respect to soil health and rainfall pattern; cropping system, crop productivity, stability and production constraints.

Integrated farming/ Systems approach:

For productive utilization of rice fallows, a farming / cropping system approach should be followed. Construction of farm ponds to provide life-saving irrigation, growing of dual purpose cultivars to meet cattle needs can be taken up.

Periodic GIS mapping:

In order to monitor impact of R and D efforts on area expansion in rice fallows under different crops, cropping systems and soil health, periodicmonitoring through GIS is required. This would ensure the successful utilization of rice fallows.

Sentinel-2 was specifically designed to collect dense time series. The mission plan from ESA foresees two identical satellites in operation (S2A and S2B). With the second Sentinel-2 (S2B launch in June 2016), the S2 constellation will achieve a revisit time of 5 days. Within the overlap areas, even higher revisit times will be possible. The temporal frequency of cloud-free acquisitions will be further increased as S2 was designed for building a virtual constellation with Landsat-8 with a high potential for global monitoring (Wulder *et al.*, 2015). Hence, compared to our study, much more data will be freely available in the near future, which will significantly impact the capturing of land cover/land use (LCLU) information (Wulder and Coops, 2014). Despite the few data analyzed in our study, our research demonstrated that even using a single image, crop classification accuracies can be achieved comparable to the outcome of the study presented in Inglada *et al*. (2015).

Conclusion:

Doubling farmers income is under serious consideration by NitiAayog/ Government of India. As a part of this, increasing cropping intensity is expressed as one of the important factors that can alone contribute to 4.9% increase in income at current rate over 10 years. This is far less than the existing potential. A study made in Pulkalmandal of Sangareddy district of Telangana holds promise for increase in cropping intensity as large areas are left fallow after harvest of rice. The moisture can be utilized for cultivating small duration cereals, pulses and forages. This requires identification of appropriate crop and cultivars, package of practices suitable for the region and policy support. The progress has to be monitored by continuous GIS mapping utilizing the availability of high resolution satellite images.

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