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Geospatial technologies for sustainable development: An Approach to improve the condition of temperate fruits

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Abstract

India is known as the fruits and vegetable basket of the world. After china, India is 2nd largest producer of overall fruits and vegetables. Agriculture is the backbone of Indian economy, hence, it's very important for us to come up with sustainable approach towards agriculture. It's necessary to involve geospatial technologies to improve the condition of temperate fruits by spatial monitoring and management. Remote sensing and GIS have emerged as effective tools for the macro and micro level mapping of natural resources. Hilly states with highly diversified terrain ranging from low hills to high mountain ranges have provided a challenge in the agriculture from further enhancing and utilizing the latest technologies as compared to the rest of the states of the country. Sustainable agricultural development requires a systematic effort towards the planning of land use activities in the most appropriate way, apart from several other institutional and policy programmed initiatives. Use of GIS and RS in the field of agriculture is increasing day by day and the applications varying from Spatial Decision support system (SDSS), yield estimation, food and security analysis, Crop simulation models, Pest management, Livestock mapping, potential sites identification etc. are some of the most commonly used ones. Today's necessity has also raised a need to share the information over internet and thus many online web based real-time application have replaced the traditional standalone applications. Hence it results in easy accessible information that can be used for policy making and implementing the new strategies in precision farming.

Introduction

Temperate fruits originate from locations which vary in specific climatic requirements, mostly grown in places where winters are distinctly cold. These contribute to horticulture industry and are essential in food and nutritional security of the country. Temperate fruit production is a major industry; the marketing and production of these fruits are labor intensive hence it is also a main source of employment (Smith and Somerset, 2003). Temperate fruits are classified on different basis like plant stature, fruit morphology, bearing fruit habit and growth pattern. According to National Horticulture Board (2018), the production of horticulture crops was 311.71 MT during the year 2017-18. Advances in germplasm and varieties have made the fruits species highly productive (Pio et. Al., 2017).

Temperate fruit are grown in different regions of India: Broadly from north (J& K) to subtropical plains in the north, to Arunachal Pradesh in the east and to very small extent in south as in the Nilgiris of Tamil Nadu (Dhillon and Rana, 2004). These are generally known as 'Hill fruits and cold region fruits'. Temperate fruits like apple, walnut, peach and cherry are grown in J&K, Himachal Pradesh Uttaranchal and other eastern hilly states of India (Atteri, 2004). These fruits do best under severe winter conditions while the other temperate fruits like plum, Apricot, grapes thrive in comparatively warmer situations. North western Himalayas are rich in genetic diversity as compared to north eastern regions (Dhillon and Rana (2004). The temperate fruits growing areas in India do not fall in the temperate zone of the world but the prevalent temperate climate of the region is due to snow clad Himalayas and high altitude which helps to meet chilling requirement during winter season.

According to National Horticulture Board, the estimate production of fruits in the year 2018 and 2019 was 96.7 MT. As given in the Table 1, fruits which are highlighted are the temperate fruits from which we can analyze the status of production of temperate fruits. The production of temperate fruits is approximately 33 MT only.

Area and production of horticulture crops			
2018 -2019			
		Area (000 Ha)	Production(000MT)
Sr. No.	Fruits	Area	Production
1	Almond	10	11
2	Gooseberry	94	1098
3	Apple	307	2371
4	Banana	874	30006
5	Ber	50	633
6	Lime /lemon	283	3221
7	Mandarin	404	4964
8	Sweet orange (mosambi)	179	2876
9	Others citrus fruits	107	1192
10.	Custard apple	38	320
11	Grapes	137	2951
12	Guava	270	4107
13	Jackfruit	187	1857
14	Kiwi	4	12
15	Litchi	93	711
16	Mango	2313	22353
17	Muskmelon	54	1145
18	Papaya	139	5831
19	Passion fruit	14	85
20	Peach	18	123
21	Pear	42	304
22	Picanut	1	0

23	Pineapple	106	1810
24	Plum	23	89
25	Pomegranate	246	2865
26	Sapora	101	1200
27	Strawberry	1	5
28	Walnut	108	301
29	Watermelon	89	2299
30	Others	237	2015
	Total	**6530**	**96754**

Table 1; Area and production of fruits in India in the year 2018-19

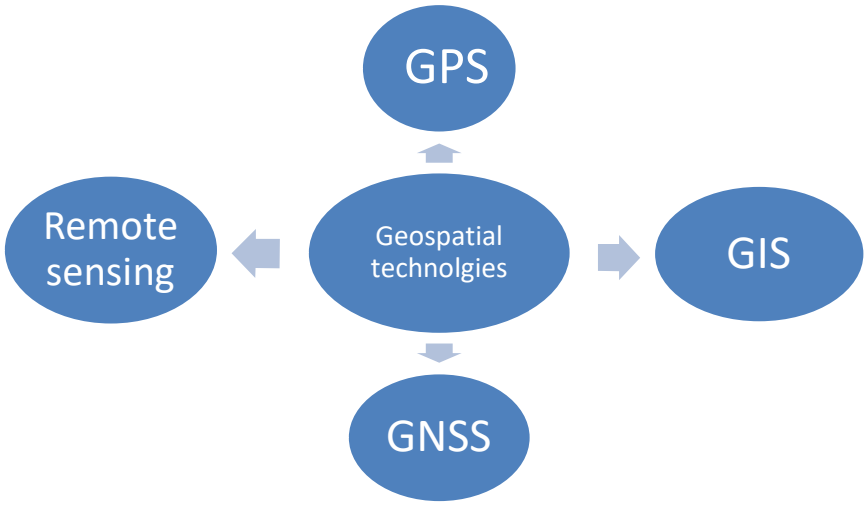
In order to increase and improve the production of temperate fruits, there is a need of some advanced technologies which includes geospatial technologies like remote sensing, GIS, GPS and advanced image processing techniques. These technologies are useful for frequent monitoring; provide regular synoptic view over large area, demarcation of spatial variation of the crops, land mapping, recommended dose of fertilizer application and many more.

Remote sensing is an interdisciplinary approach which involves various sciences like spectroscopy, satellite launching, Computer, optics, electronics and photography (Pujar et. Al., 2017), basically it is a process of obtaining information about water, land or any object without having any physical contact between the analysis object and sensor. We are learning a new way of seeing through remote sensing. GIS is geographic information system which is a framework for gathering, managing, mapping and analyzing the data. Remote sensing and GIS play a crucial role in monitoring farm practices at large scale (Sood, et. al., 2015). They are also useful in yield estimation, weed mapping, disease management, and soil mapping and considered as very powerful tools. GPS or global positioning system is a valuable tool in spatial data acquisition. Ground truthing is main application of GPS as it records the correct position continuously (Panda, et. Al., 2010). DSS and SDSS models are also used in designing the plan which proved to be helpful for farmers to solve the problems related to niche identification, pest management etc. These technologies are generally used to monitor the crop growth. A layer based system is developed with the help of RS and GIS which gives the best models for practicing the precision agriculture (Sood, et. al., 2015).

Organic farming was the primary type of agriculture which was practiced in pre historic times and basically relies on techniques such as green manure, crop rotation and biological pest control but in today's world there is a need of using these geospatial technologies which give the researchers and farmers an accurate assessment about their fields and ways of improving them (Prakash et. al., 2016). Major concern of today is to provide the huge population with an indefinite food supply, healthy fruits, which is also the economic, social and environmental concern and this can only be achieved by sustainable development. The overall goal of this paper is to provide a review of studies that use geospatial technologies mainly remote sensing, GIS and GPS for the improvement of temperate fruits which will results in sustainable development of temperate horticulture. These technologies are the effective tools which are important in description, detection, quantification and monitoring of environmental changes which finally leads to sustainable development.

Geospatial technologies:

Geospatial technology which is also referred as geomatics is an interdisciplinary approach that includes many fields like mapping, remote sensing, surveying, geodesy, photogrammetry, Geographic information system (GIS) and global navigation satellite system (GNSS) (Aina, 2012). It is information technology which manages displays, integrates, interprets, analyzes and finally acquires the data in spatial, temporal and geographic context (Klinkenberg, 2007). This technology also lays a vital role in EIA (Environment Impact Assessment). These geospatial technologies can be applied in monitoring of soil erosion, natural resources (Air, water, land), reason of sea level rise, global warming, ground level ozone, change detection analysis and many others (Satapathy et al., 2008). Geospatial tools are also used in various development sectors like tourism, petroleum exploration, hydroelectric power projects, mining and transport etc.



GIS for Sustainable development:

India is 2nd most populated country in the world and in order to meet the nutritious demands of the country, it's important to use some advanced technique like GIS as it helps the agronomists, community planners and farmers to research and create work which is sustainable. Persons working in Agribusiness, use GIS software for land management, precision farming business operations and many more (Prakash et al., 2016). Some sustainable agencies predict drought conditions and monitor water resources with the help of GIS (Tarawneh et al., 2008). Accurate Synoptic temporal and spatial data on land cover, hydrology, surface hydrology, vegetation and aerosols are acquired from advanced Technologies like remote sensing and GIS. We can classify GIS data in Graphic and attribute data (Satapathy et al., 2008), it is a powerful set of tools for collecting, storing and retrieving the data and finally transforming and displaying the spatial data for some purpose (Burrogh and McDonnell, 1998). Spatial data is generally in the form of layers that tells about the topography or environmental elements. Worldwide, role of GIS is expanding in the agriculture production as it is helping the farmers in increasing the farm production, reduce cost and effective use of land (Sood et al..2015)

Remotes sensing for sustainable development

Remote sensing has a great use in estimation of area coverage, mapping and classification of landuse and land cover features like vegetation, soil, water, forests and manmade activities etc. (Singh et al., 2014). Vegetation can be extracted using remote sensing through satellite imagery based on interpretation elements like the image color, texture, tone, pattern and association information, etc. The near infrared band (>700nm) of satellite images is insensitive to human eyes but this band is one which gets reflected at a higher proportion from the incident sun light from healthy vegetation as this band is sensitive to leaf cell structure and water content of leaves. Basically, the reason why a leaf looks green is that the chlorophyll absorbs blue and red spectra and reflects the green. The unique characteristics of matter are called spectral characteristics (Singh et. al., 2014). Space technologies have been successfully utilized worldwide in natural resources and disaster management, with the availability of high-resolution remote sensing data, monitoring of land, water resource and coasting at local scales has become possible to resource managers as a way to create timely and reliable assessments.

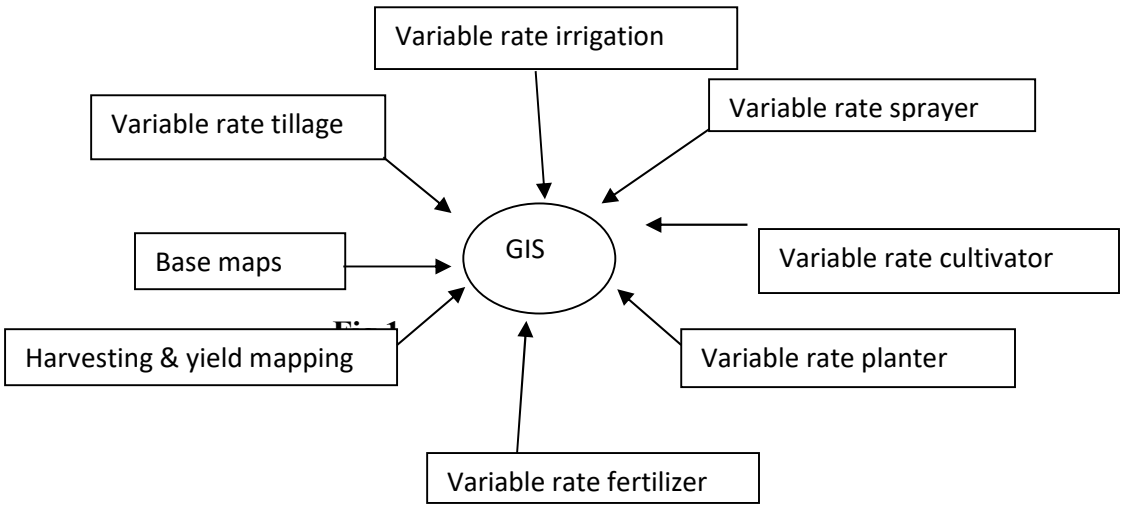
GPS for sustainable development

The origin and efficient use of Global Positioning System (GPS) has not only strengthen the ease and use of spatial data acquisition, but this has also expand the approach integrated with remote sensing and geographic information System (GISS). In eighties (GPS) Global positioning system becomes a useful tool in spatial data acquisition. The GPS devices have improved form traditional hand held devices having accuracy of nearly 10 m on ground to now with differential GPS (DGPS) to accuracy in cms. Scenarios in hilly terrain like Himachal Pradesh (India) becomes much more adverse where the field areas are very small. The cropping pattern in such terrain already leaves farmers with less options and to implement precision farming is itself a bit impossible. The global positioning system (GPS) makes possible to record the in-field variability as geographically encoded data. It is possible to determine and record the correct position continuously. This technology considers the agricultural areas, fields more detailed than previously; therefore, a larger database is available for the user. The accurate yield data can be reported only in the points where GPS position recording has happened. GPS receivers coupled with yield monitors provide spatial coordinates for the yield data. This can be made into yield maps of each field. Information collected from different satellite data and geo-referenced with the help of GPS can be integrated to create field management strategies for chemical application, cultivation and harvest (Liaghat and Balasundram, 2010). The development and implementation of precision agriculture or site-specific farming has been made possible by combining the Global Positioning System (GPS) and geographic information systems (GIS). These technologies enable the coupling of real-time data collection with accurate position information, leading to the efficient manipulation and analysis of large amounts of geospatial data. GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping

Applications of geospatial technologies

1. **Precision farming:** Generally, also termed as satellite farming, an approach to farm management. It is based on information technology which allow the producer to gather the data

and information for better decision making (Kamble 2009). It is an integral part of sustainable development. Site specific management system is also adopted with the help of remote sensing GIS and GPS, it gives the ability to farmers to use their crop inputs very precisely which includes fertilizers, pesticides, irrigation water and tillage. The effective use of these inputs' will increase the crop yield or quality without polluting the environment (Tripathi et al., 2019).



Precision farming overview

Tripathi et al., (2009) observed that the in precise farming a particular field is divided into management zones, known as grids based on several factors, that help in crop production like soil pH, pest infestation, nutritional status etc. and with the help of GPS can be identified. It was further observed that precision farming is useful economically as well as is an environmentally friendly technique. Sood et al., (2015) determined that tuning of production and precise tracking is done by precision farming, which shows that integrated use of remote sensing, GIS and GPS allow the farmers to get comprehensive and real time data for management.

Crop Condition and yield estimation

With the use of Normalized Difference Vegetation Index (NDVI) through remote sensing we can identify the crop condition, it tells the health and density of the vegetation using near infrared radiations (Deb et al., 2018). With this method crop state and yield estimation can also be considered. Remote sensing is proved to be most efficient tool to estimate the crop yield of various annual crops but it is very less used in fruits and nuts (Maja and Ehsani, 2010; Usha et al., 2013). The equation used to calculate the NDVI is

NDVI=NIR-RED/NIR+ RED, Where NIR and RED stands for spectral reflectance measured in the near infra-red and red or visible regions, respectively. NDVI has invariably been used to check

the greening pattern of a landscape. It has vide uses in monitoring vegetation in various landscapes and terrains. Ennouri and kalllel (2019) stated that these geospatial technologies provide information very frequently, repeatedly and at an inexpensive value to permit for recovery of crop. It was further stated that integrating these technologies is simple and cost effective in observing and planning the crop situation. Dhadwal and Ray (2000) observed that we can study remote sensing in early crop condition assessments and get pre harvest crop yield estimates. They also showed the yield variability with the NDVI based models of single date for some states of India.

Soil moisture

Soil moisture measurement is undoubtedly very essential, which have direct impact on well being of ecosystem. It play an important role in controlling and regulating interaction between atmosphere and land surface (Babaeian et al, 2019). Using active and passive sensors of remote sensing we can determine the soil moisture, as the purpose of active sensor is to illuminate the target and record the backscatter which result in high spatial resolution. But low accuracy in contrast in passive sensors compute naturally radiated EM waves which are exceptionally accurate but with poor resolution. SMAP Soil moisture, is a project launched by NASA to use these sensors in their best way (Deb and Singh, 2018).

Gharechelou et al., (2016) found that soil Spatial variability and location of samples are the biggest challenge for Soil Mapping as spatial variability is mostly dependent on various environmental factors like topography, soil properties, vegetation, land use, radiation and precipitation. Hence, to overcome these challenges Geospatial technologies are used, and with the help of GIS they have done geo environmental monitoring, mapping, evaluation and spatial analysis. Further, LUA (Land Unit Area) map can also be created with the help of GIS.

Detecting pest and disease occurrence

Worldwide, it has been observed that diseases in plants affect the agriculture industry and finally the economy of the country. To detect pest and disease or for the effective management there is need of monitoring plant health. Martinelli et al., (2015) identified the primary infections in the plants by coupling remote sensing and spectroscopy based methods,

Usha et al., (2013) proved that detecting changes in plant pigments, leaf skeletonizing which are caused by pest disease can be identified with the help of remote sensing. Abdulridha et al., (2019) detect the citrus canker using UAV-based remote sensing technique applying machine learning and hyper spectral imaging and achieved 100 % accuracy in classification and identifying the canker infected trees.

Conclusion

This review gives a comprehensive approach on application of geospatial technologies for sustainable development. These technologies will help in providing real time data, quality checking and location enabled data analysis. One of the major benefits to use these technologies is that it provides a spatial overview which can be referenced by millions of users. With the help of these technologies we cannot do the field mapping but also can be used to monitor the crop at various

stages even they are also useful in soil mapping and disaster management. Therefore an approach has been made to use such type of technologies in improving the condition of temperate fruits.

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