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Design and Develop the B2C Farming Information System Solution using Mobile and Web Geospatial Development Technologies for Smart Supply Chain of Fruit Crops of UP, India

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Abstract:
The main objective of writing this paper is to use innovative blend of open source geospatial and software development technologies, for maximizing benefits to both exporter/buyer and grower/farmer, by establishing smart supply chain of the fruit crops of UP, India The striving endeavour drone to build and/or utilize develop GIS, web GIS Portal, and Mobile Application by synergizing computer . In this, this anomalous problem can be solved by creating a web GIS portal and mobile application by coordinating computer science, GIS, remote sensing and mobile technology. After analyzing the satellite remote sensing data, the information of various Orchards are extracted and converted to GIS feature geodatabase. The format is converted and imported into the mobile application, with the help of Geographical Coordinates, the fruit related information of their field be filled by grower/farmer through handy user-friendly vernacular Mobile Application. The submitted information pulled on created user-friendly GIS Portal. After filling it, the web will be updated automatically on the GIS portal. With the help of latitude and longitude, all the information of crop information of the farmer such as which variety of fruit is available in the field and how much quantity can be filled in the mobile application. After filling it, the web will be updated automatically on the GIS portal. All buyer's list will already be available on the web GIS portal, this will end the problems of both the farmer and the buyer.

Keywords: Leaflet.js, Geoserver, PostgreSQL, WebGIS, Grower/Farmer, Exporter/Buyer, Android SDK

Introduction:
Horticulture plays a vital role in country's economy, it consists approximately 33 percent of total agricultural production of the country.
Innovation plays a significant part in cultivating and farming practices; and with the appearance of advanced innovation, the degree has enlarged. Improvement in technology is driving a headway in agricultural practices which is subsequently that decreasing disasters and augmentation adequacy. This is emphatically affecting farmers. Utilization of advanced technologies is driving consistent improvement in horticulture; this is helping in increasing income of farmer's community.

The objective of this research is to develop a data driven software infrastructure where horticulture goods producers can update their offerings from their orchards to buyers anywhere in the world.
This will connect both of the parties and eliminate middlemen exploiting innocent farmers.
We have taken orchard's data of 36 districts out of 75 districts of Uttar Pradesh, India viz; Allahabad, Chandauli, Sonbhadra, Baghbpat, Kanpur Nagar, Siddharthnagar, Maharajganj, Jaunpur, Jhansi, Bahraich, Sultanpur, Kannauj, Mainpuri, Lucknow, Mirzapur, Varanasi, Ambedkar Nagar, Balrampur, Chitrakoot, Gonda, Auraiya, Azamgarh, Kanpur Dehat, Ghazipur, Barabanki, Hamirpur, G.B. Nagar, Banda, Agra, Etawah, Bhadhohi,Bulandshahar, Mahoba, Deoria, Kushi Nagar.
The key problems being addressed for this research are:

- Vendors are the one knowing the trends of the market according to end consumer's behavior, keeping Their shelf updated with the varieties in high demand regularly with less possible expenditure on transport and other things is challenging.
- Global vendors get huge demand of certain varieties in good price but find them self-unable to fulfil it due to perishability of these goods.
- Uttar Pradesh consist vast geographical area producing diver's varieties of horticulture goods diversely, searching for a particular variety of product is difficult for a vendor/consumer, this makes geospatial technology play an important role in connecting both the parties

Farmers on the other hand are the one knowing the time and quantity of their offerings but Farmers are less educated their connectivity with computers is rare, making them capable in updating software infrastructure with data about their offerings regularly is another challenge.
Horticulture goods are highly price able and both farmers and vendors generally get a small span of time to showcase their offerings, geospatial technology's analyzing tools like proximity analysis will establish relationship among all of the stakeholders to ensure less wastage of many/goods & profits of each.
Key features of the resultant Software infrastructure from this research:
Developed framework consists of a mobile application loaded with advanced functionalities of Google maps APIs and advance geospatial analysis being compiled on remote server this mobile application is designed by keeping in mind that user(farmer) is less educated which enables farmers to mark their orchard among several pre digitized orchard(using remote sensing technology)and provide information about it like: number of varieties present in the orchard, average productivity being expected from trees of each verity every crop year, personal information about himself (mobile number, name).
On the other hand, this framework consists of a geospatial web portal which enables vendors/consumer find and navigate to orchards/ group of orchards in certain area/nearby fulfilling his demands.

Methodology:

We developed our system using open source and freely available resources.

Web-GIS: The interface is designed using HTML, CSS, Vanilla Java Script and other java script libraries like Jquery and Ajax, and mapping library LeafletJs. To manage backend we are using Springboot framework of Java. It is microservice-based framework and used to make a production-ready application. Using springboot framework we are creating Rest API.

API provides data, fetching from database. Web-GIS is somehow similar to client server architecture**.**

Database: We are using PostgreSQL for storing, managing and manipulating our data. PostGIS, an extension of postgreSQL helps in handling spatial data. This database is capable of handling both spatial and non-spatial data. For both Mobile application and Web Portal we are using a PostgreSQL database.

Geoserver: It is an open source server for serving geospatial data. It is used for publishing spatial data. It can handle raster as well as vector data upto very large size. It produces high quality maps, these maps can easily handle to render hundreds to thousands of map layers. Using Geoserver, We can produce WMS, WFS, WCS and WPS. These services are used to create map on web portal to show visual location of orchards.

Tomcat: It is an application server software for Java programming developed and maintained by the Apache software foundation. It provides an environment in which our Web Portal and Rest API is running. Tomcat is responsible to listen all requests done by clients and providing the necessary response back to the client.

Following figures are showing how methodology is flowing in development of this solution.

Flowchart for data preparation:

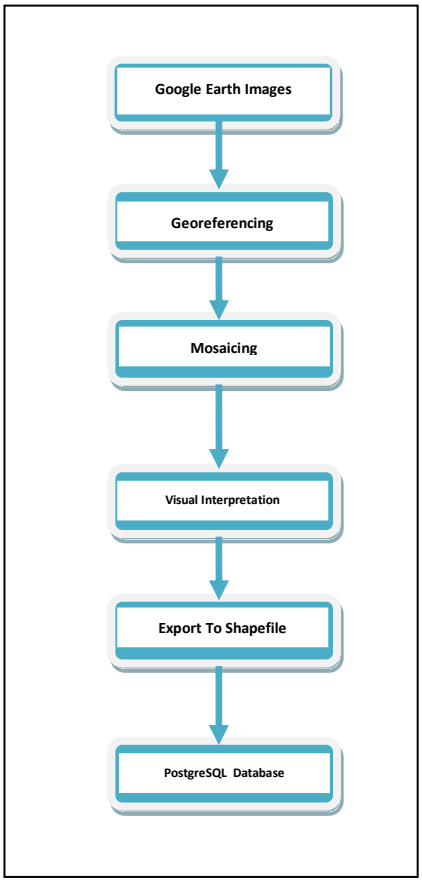

Fig 1(A)

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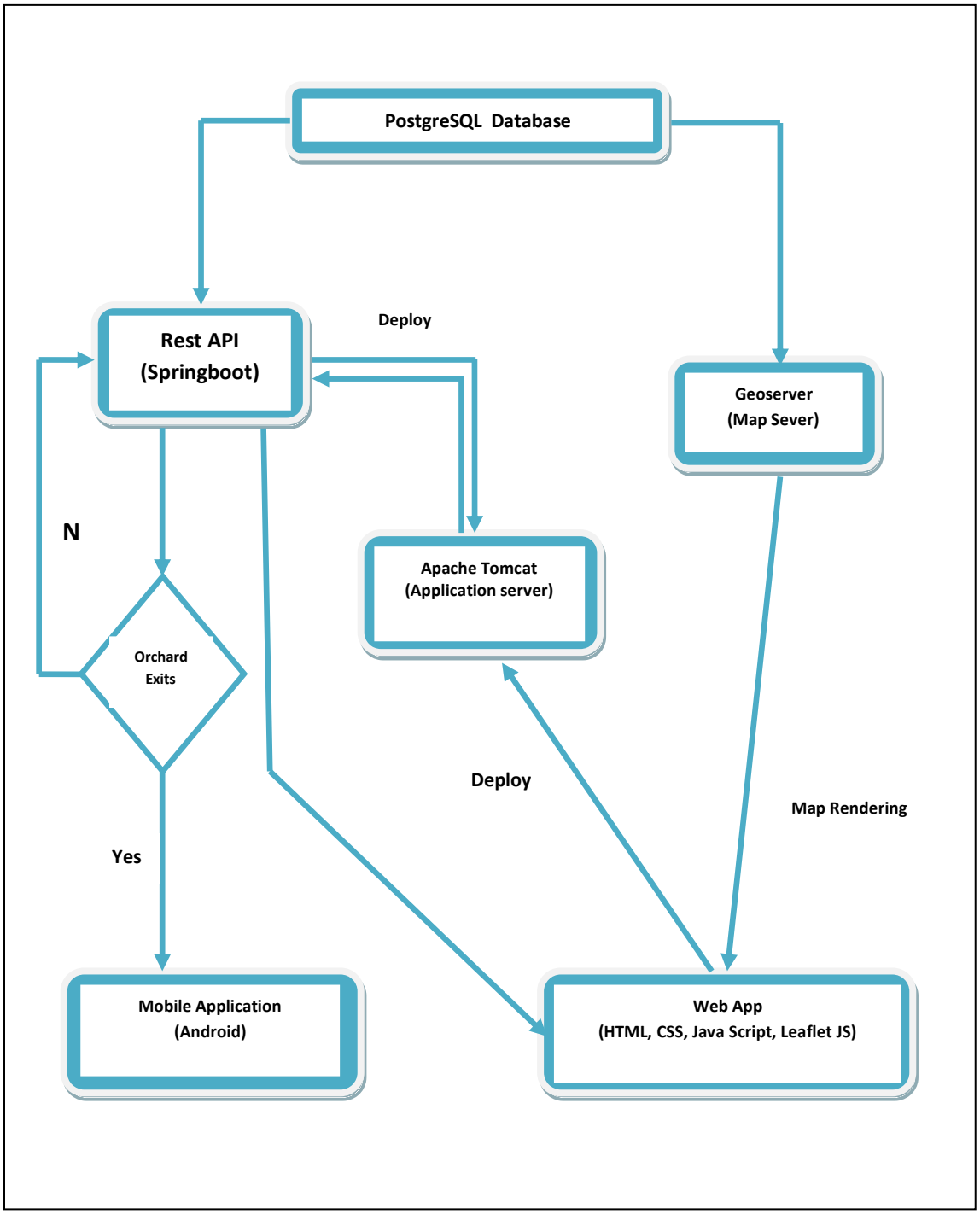
Flowchart for Integration of Web GIS Portal and Android based Mobile Application: -



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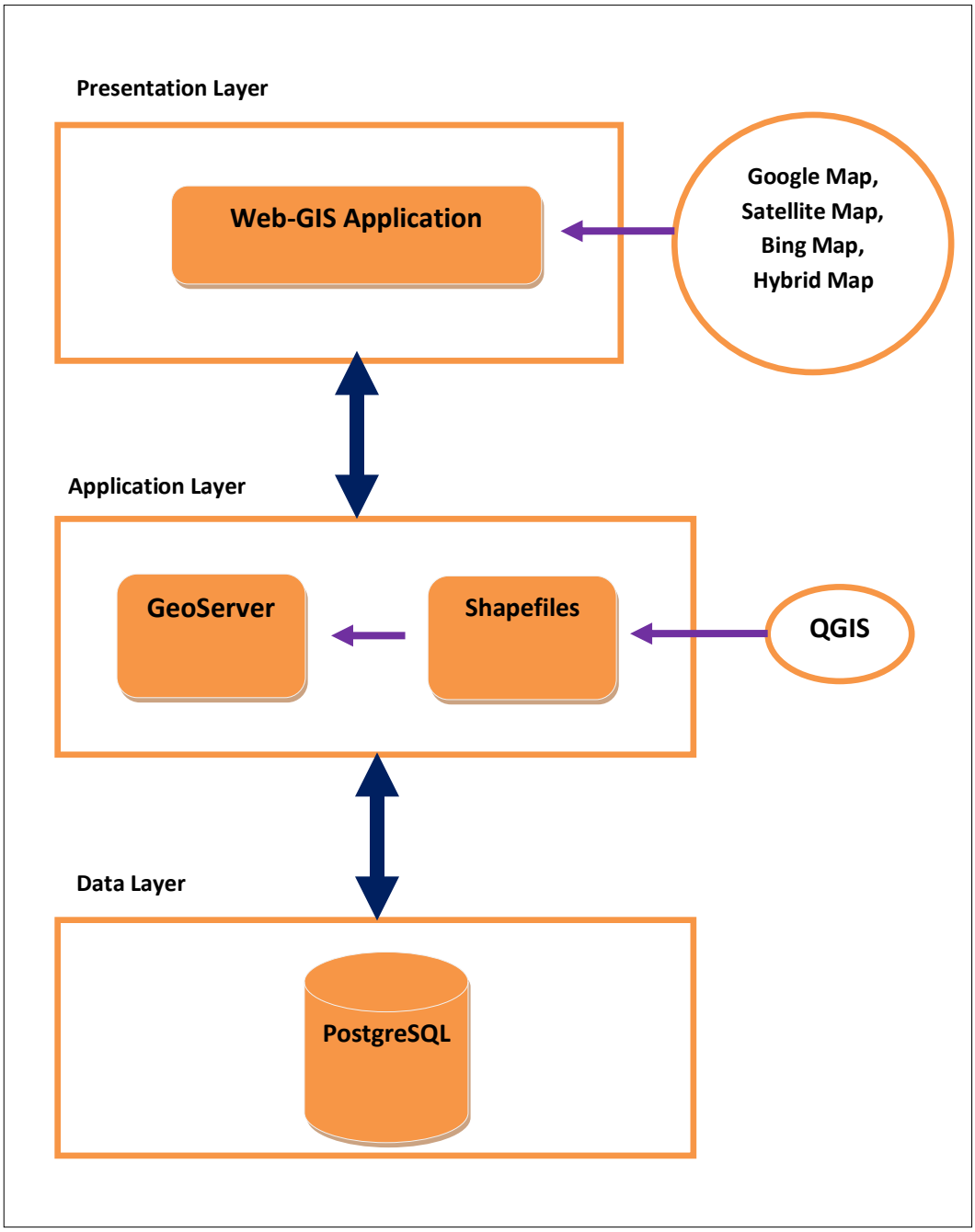
Network flowchart for Integration of Web GIS Portal and Android based Mobile Application:-



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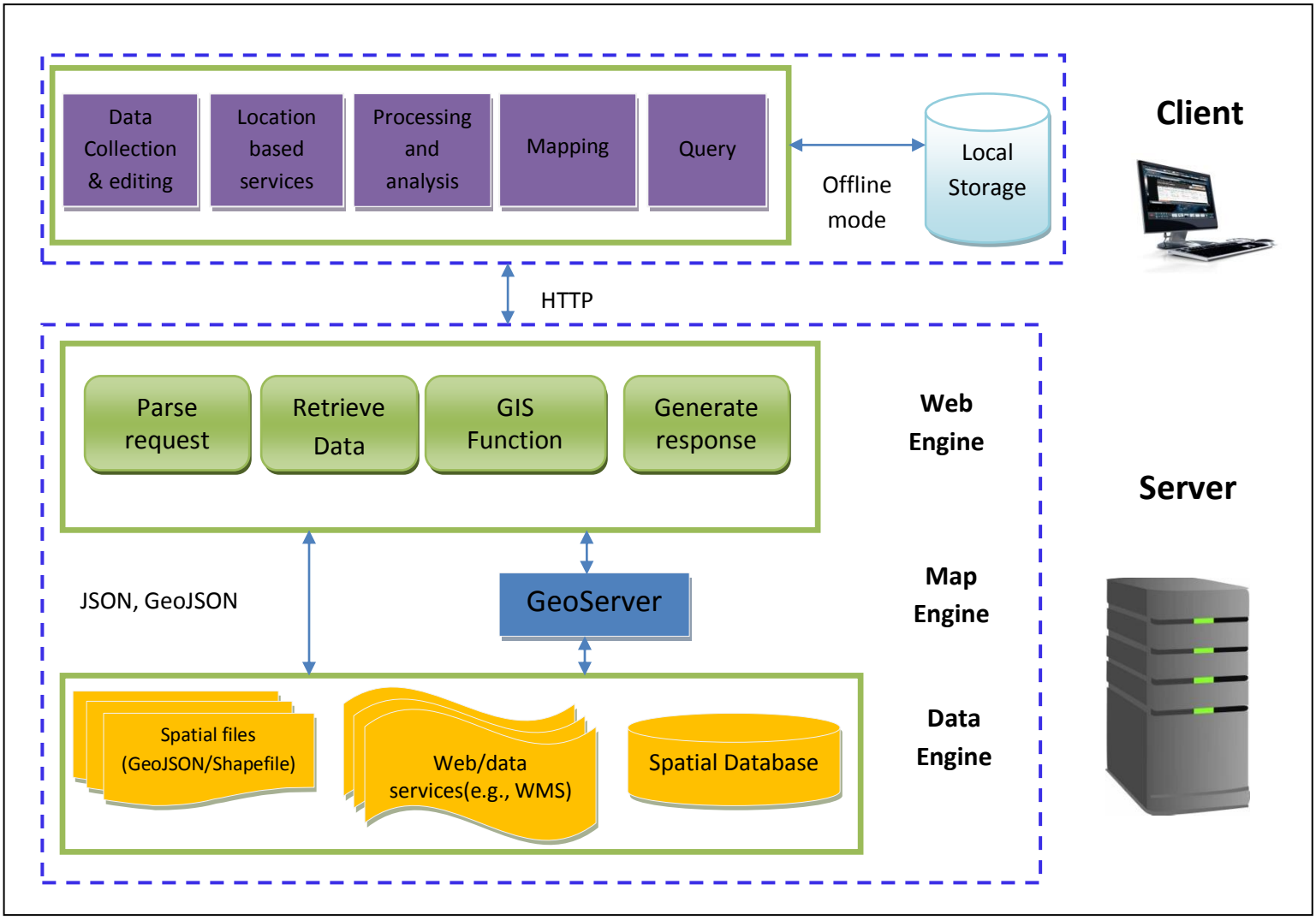
Architecture of developed/created Information System solution:-



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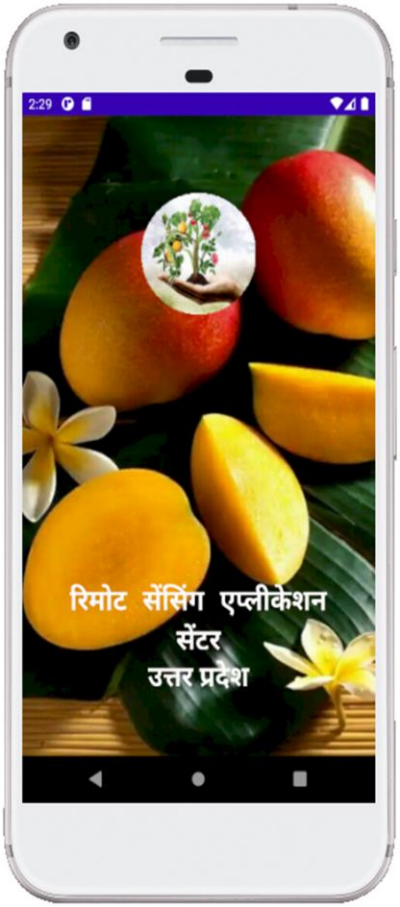
Mobile Application: Mobile application for farmers to facilitate them for submitting information about Fruits they are growing in their orchard, to portal's database.
Fig:2(a) shows Welcome screen of the application.
In Fig:2(b) Asking user whether he wants to list his farm's products for buyers or find buyers for his product.
When user selects first option i.e. to list his farm's products for buyers, application makes sure that farmer is standing in his farm so that correct locational information of his farm can be sent to database.



Welcome Screen

Fig:2(a)

Home Screen

Fig:2(b)

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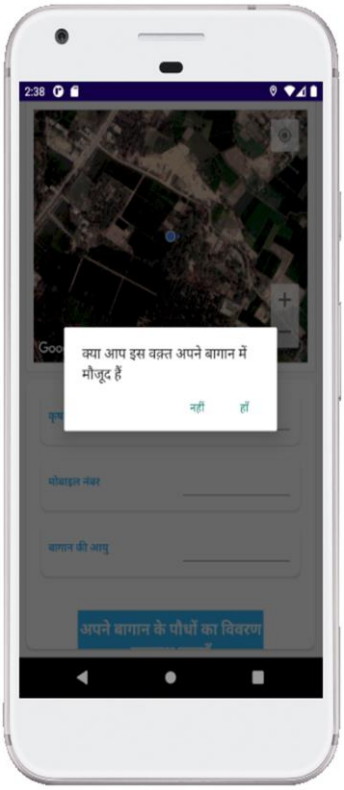
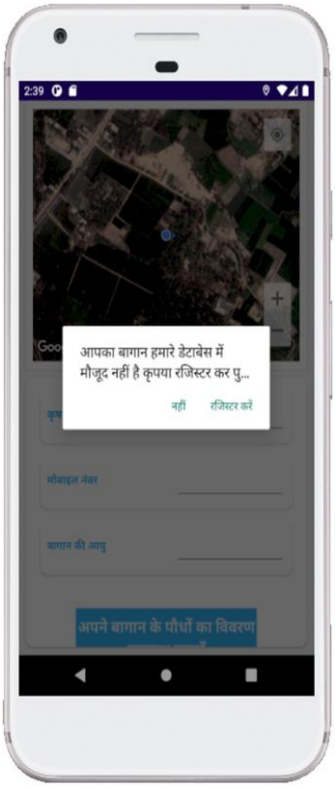
To list farm's products using this application it is mandatory for the farmer to be present at his farm so that received information can be cross verified using remote sensing data and orchard's GIS boundaries can be marked as shown in Fig:2(c)

When user verifies that he is standing in his farm only, application checks (in background) if his orchard is already listed in our database (by searching the database using received locational data of user).

(A) If his orchard is found user can provide these information which can be updated for his existing orchard, (B)If no orchard is found after searching our database, application generates a new entry in GIS database and information about the same is also saved (in background), which is cross verified by GIS analyst using satellite data, after this verification if received data is found correct, verified farms are forwarded to web portal for buyers as shown in Fig:2(d).

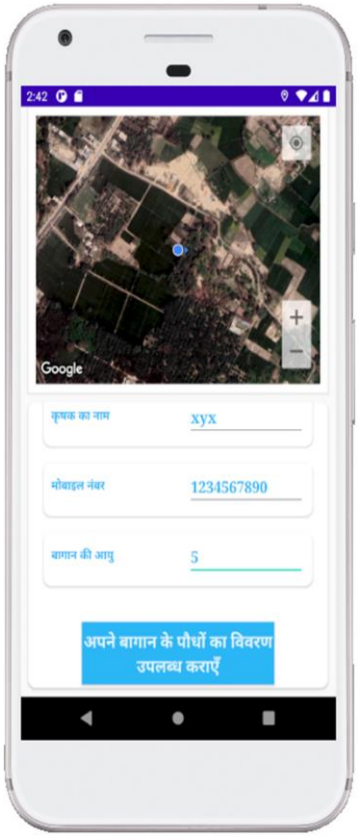


Submitting Data-1 Fig:2(c)



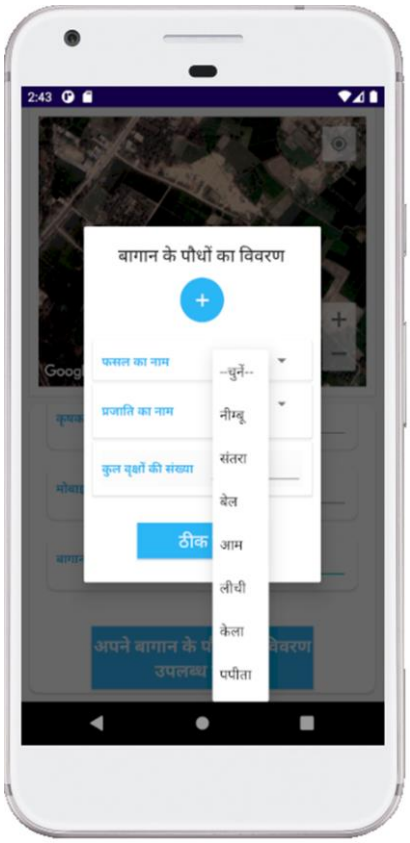
Registering Orchard Fig:2(d)

Farm/orchard can contain trees of various fruits and their sub varieties, using this screen farmer can provide descriptive classified information about his farm, also average productivity is being asked, which can be updated by farmer each Cropping year. A distinct packet of farms locational information, it's owner, and varieties that can be found in it are stored in database after submission. These process can be shown in further figures.



Submitting Data-2

Fig:2(e)



Selecting Fruits being grown

Fig:2(f)

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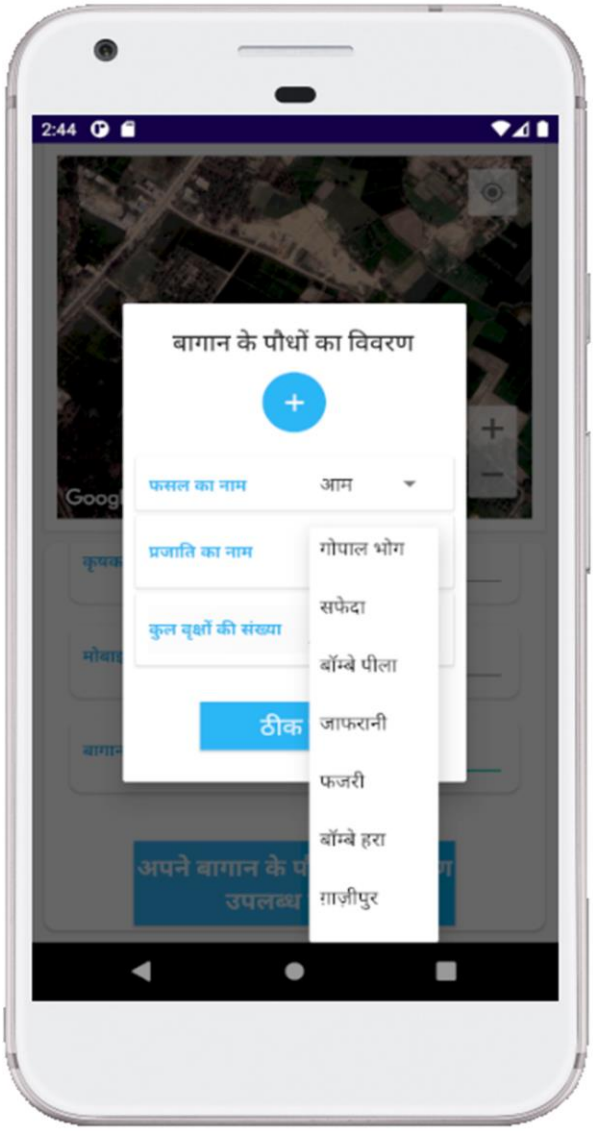
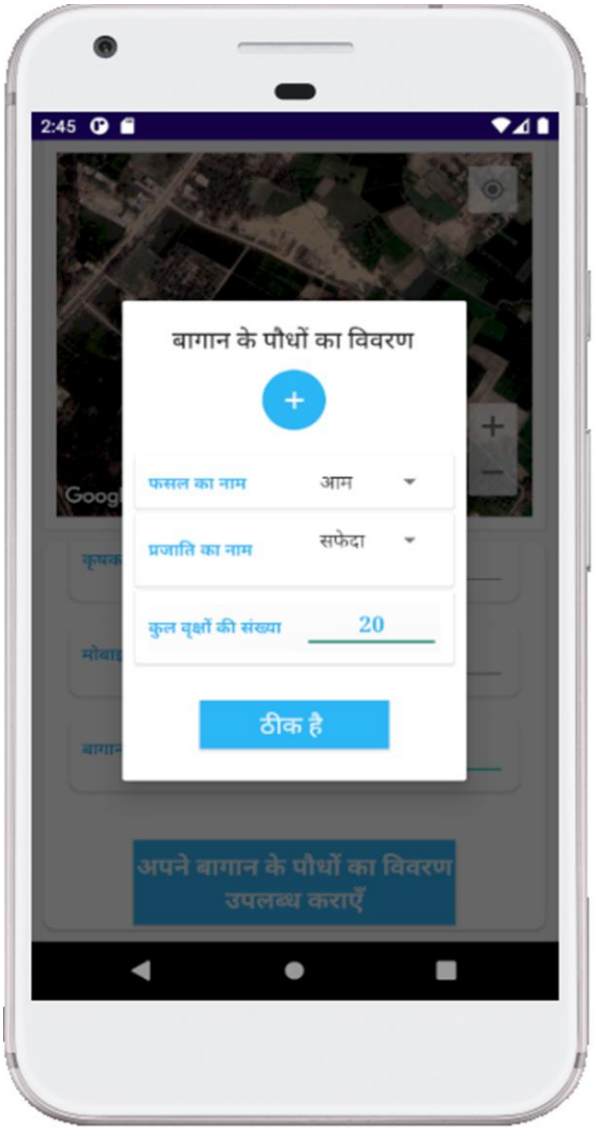


Selecting Fruit sub type

Fig:2(g)



Number of trees

Fig:2(h)

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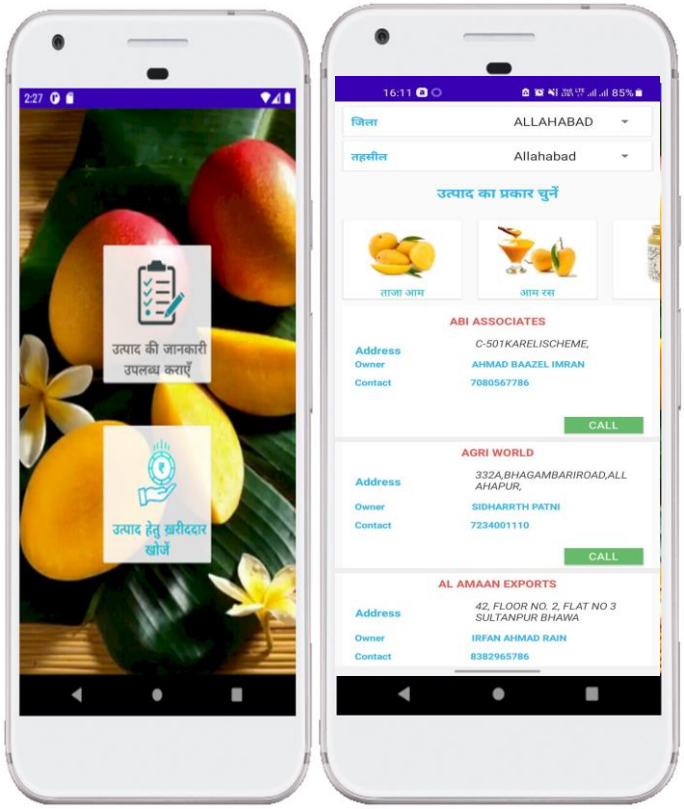
Back to selection screen, if user chooses second option i.e. finding buyers for different products produced using agricultural goods he is forwarded to a new screen as shown in fig:2(i). And

Mobile application Bonus feature: Farmers can find and contact nearby potential buyers for their products. Here application asks user about his district and tehsil, then user can find different buyers listed in our database who can be potential bulk consumers for their orchard's output, user can click on call button to make a deal as shown in fig:2(j)



Home Screen

Fig:2(i)

Finding Buyers near by

Fig:2(j)

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Web Portal: Web portal is for buyers. They can easily interact with this. All the information of orchard which is provided by mobile application and data is prepared by GIS and remote sensing is showing on This Web GIS Portal. Following figure is the home page of our web portal.

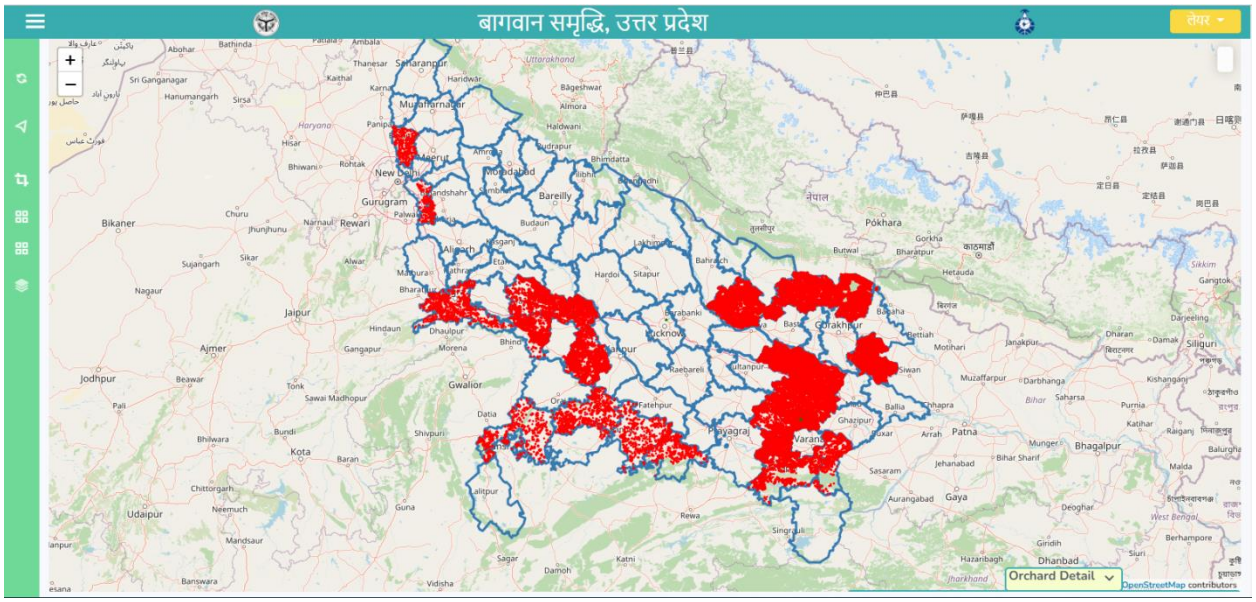

Fig:3(a)

In fig: 3(b) Toggle menu button is used to toggle left side menu pane.

In the layer button we can select layer which is showing on map.

Numbers pointing to tab is used for:

1. Default Tab is used to re-locate map position.
2. Navigate to the location: on clicking this tab, Navigation popup is open. We can select district and tehsil from District dropdown and Tehsil dropdown menu as shown in fig: 3(b)
3. Choose fruit: It used to choose fruit as shown in fig: 3(f) and its variety as shown in fig: 3(h).
4. Print tab is used to print map. We can print selected area of map as shown in fig: 3(j).
5. Remove button is used to remove all these popup.
6. Base Layer: It is used to choose base map layers.
7. Zoom-In is pointing to plus button and Zoom-Out is pointing to minus button. These buttons are used to control map zoom.

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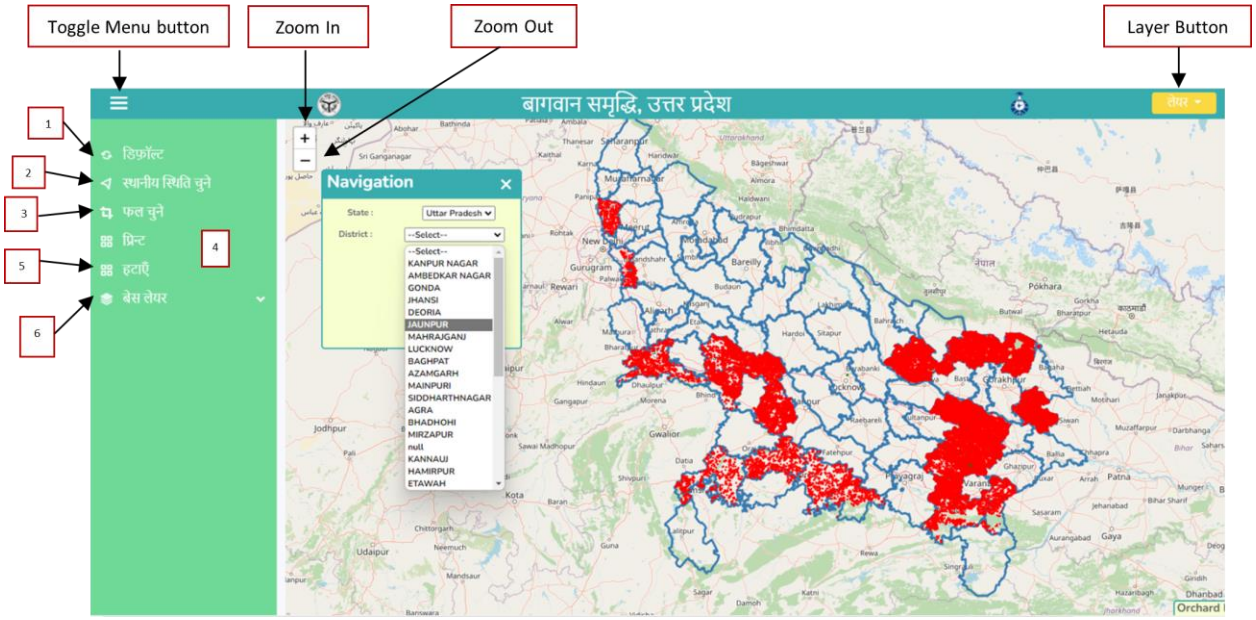

Fig:3(b)

Selected district is shown on map as district is selected from district dropdown menu it shown in fig: 3(c). Then select tehsil from dropdown. Selected tehsil is zoomed to map shown in fig: 3(e).

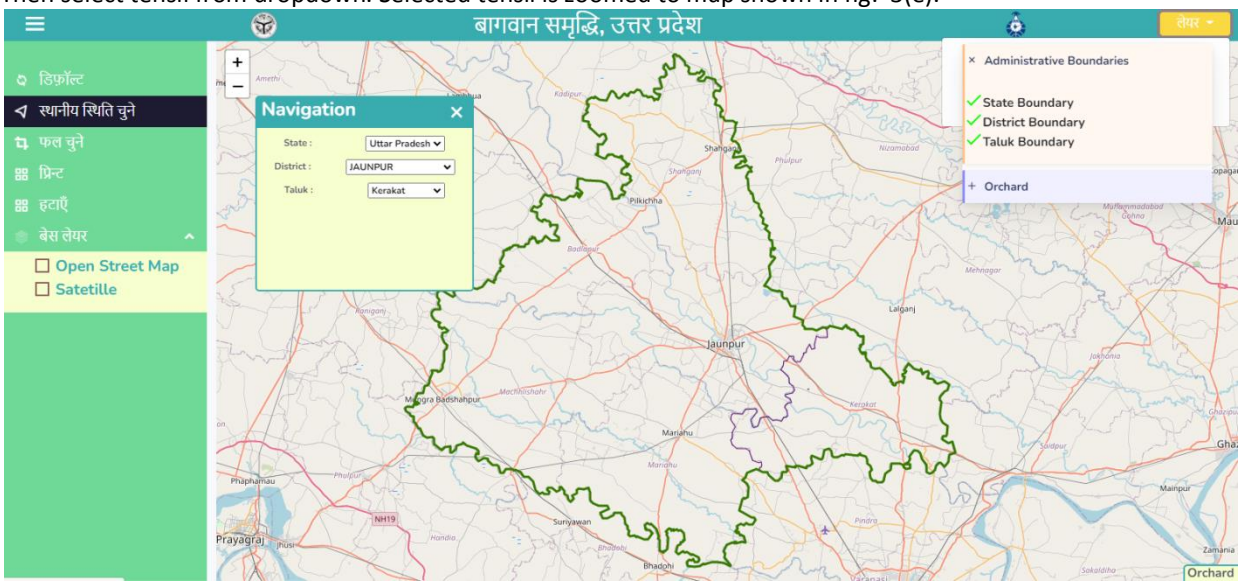

Fig:3(c)

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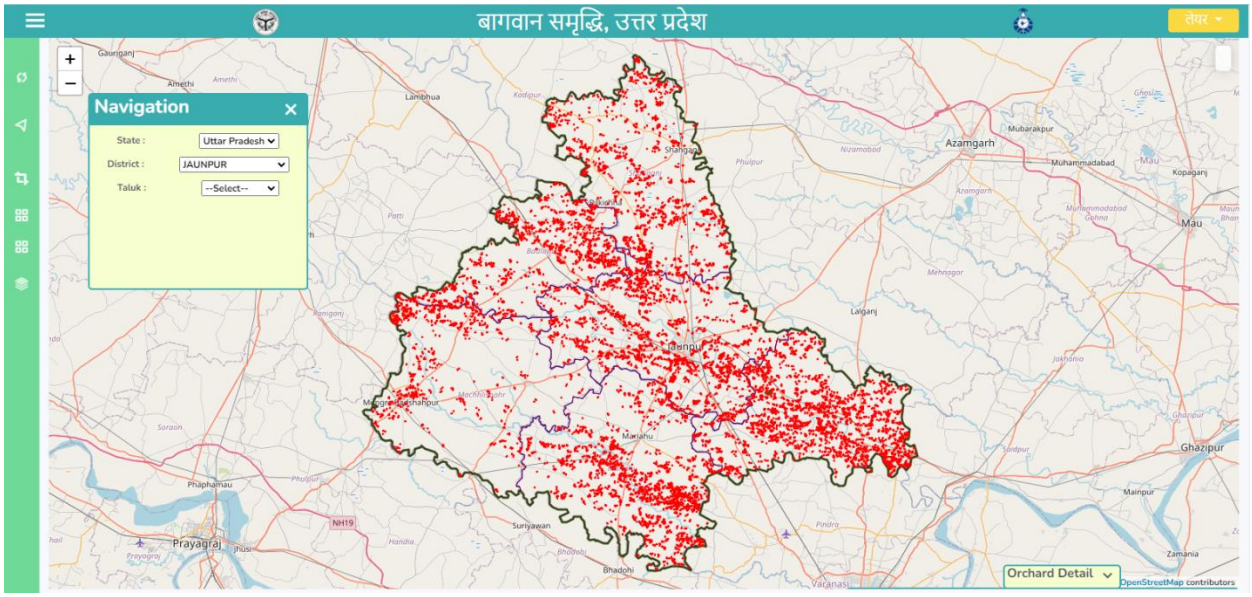

Fig:3(d)

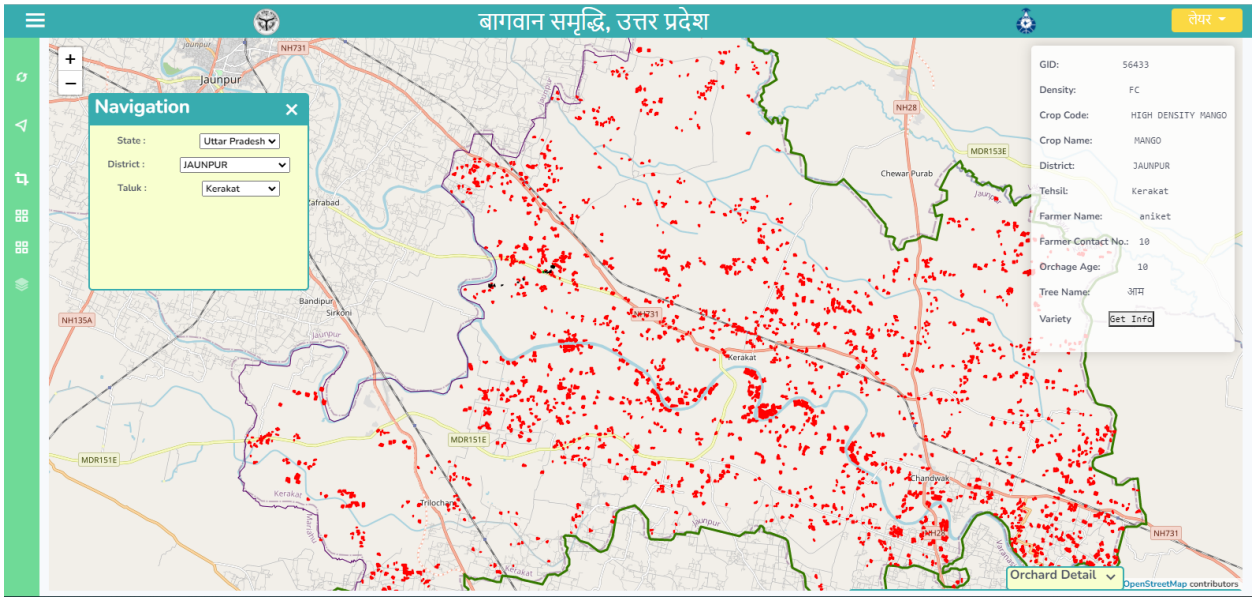

Fig:3(e)

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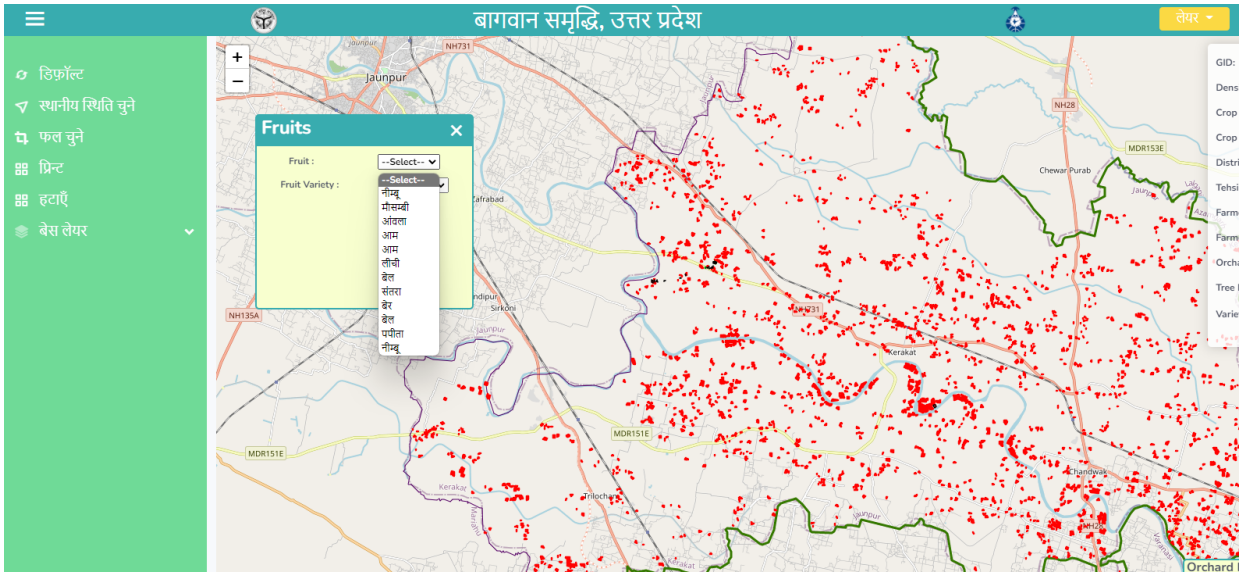

Fig:3(f)

Select fruit from fruit dropdown option, all orchard of selected fruit is highlighted on map as shown in fig: 3(g).

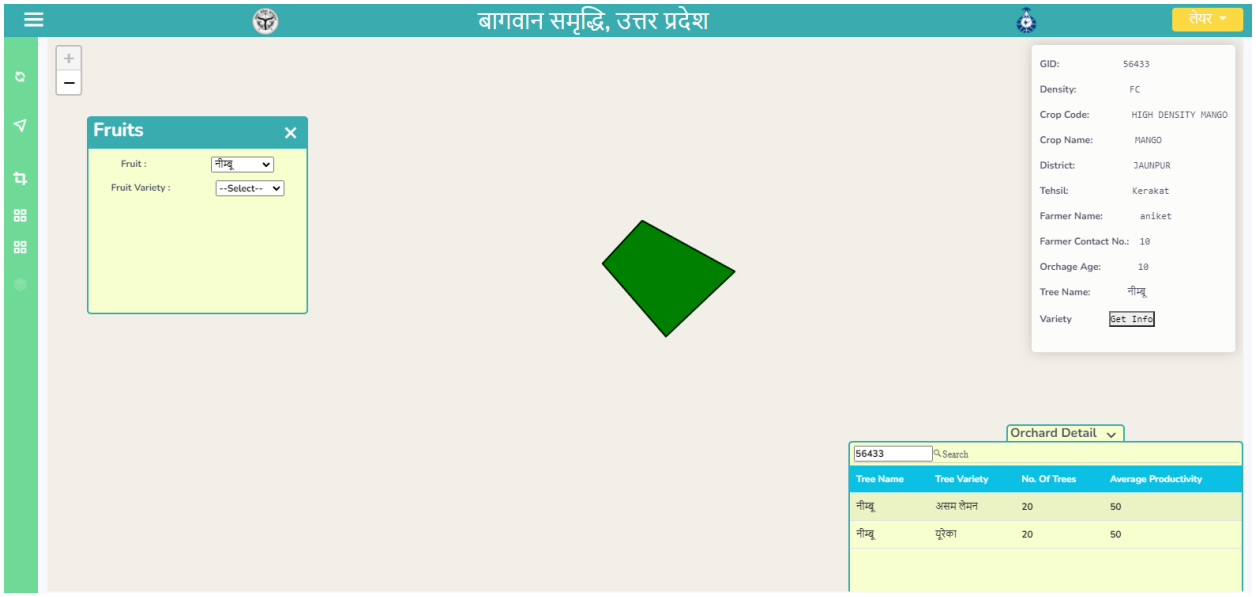

Fig:3(g)

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Select fruit variety from dropdown, all orchard of selected fruit variety is highlighted on map shown in fig: 3(h).

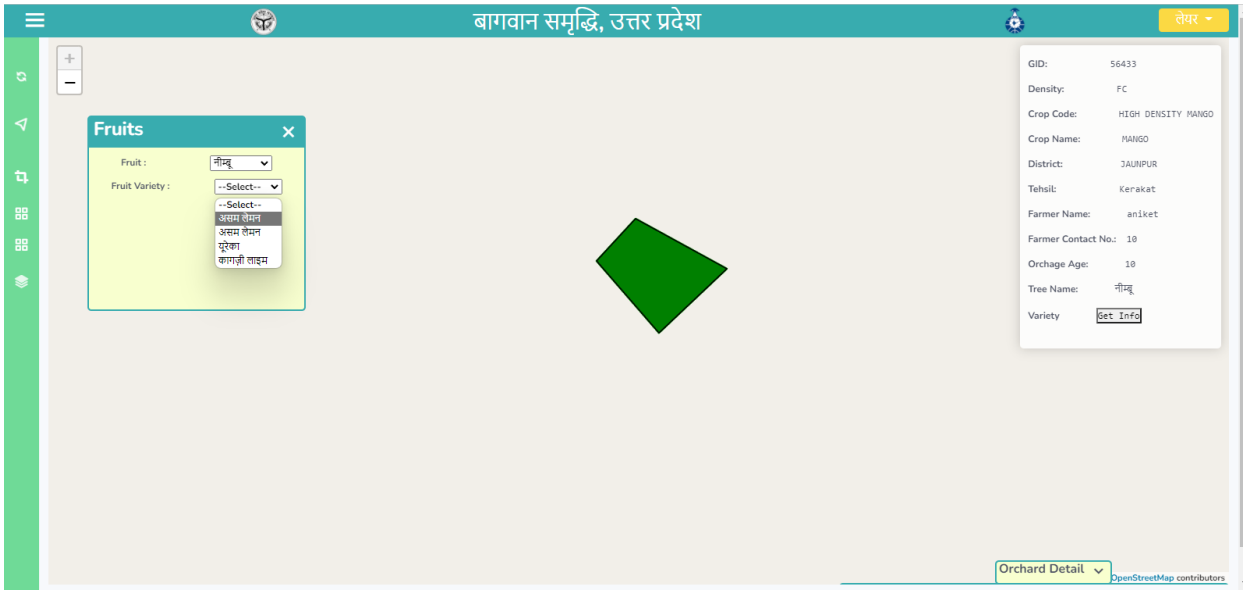

Fig:3(h)

Click to the orchard we get information like farmer-name, farmer contact-no, district and tehsil of that orchard. This information is shown in top-right corner in map.

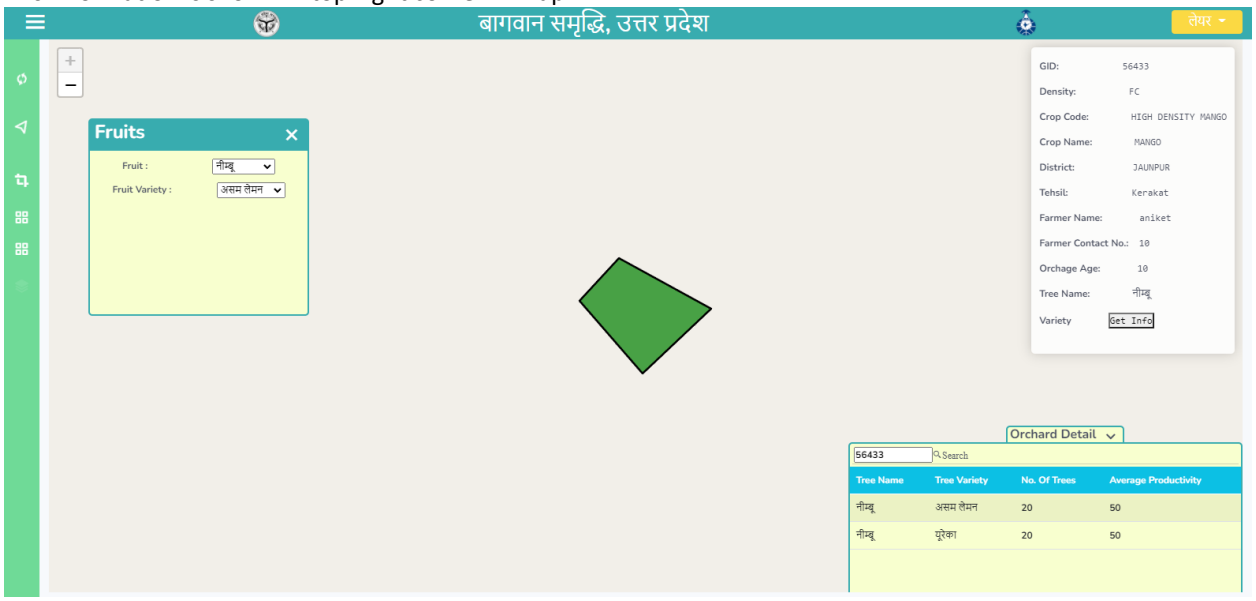

Fig:3(i)

To get more detailed information click to the Get Info tab, a table is shown in bottom right corner of map. Different variety of fruits and their quantity is shown in this table.
Fig: 3(j) shown printed map document. We can save it as pdf format.

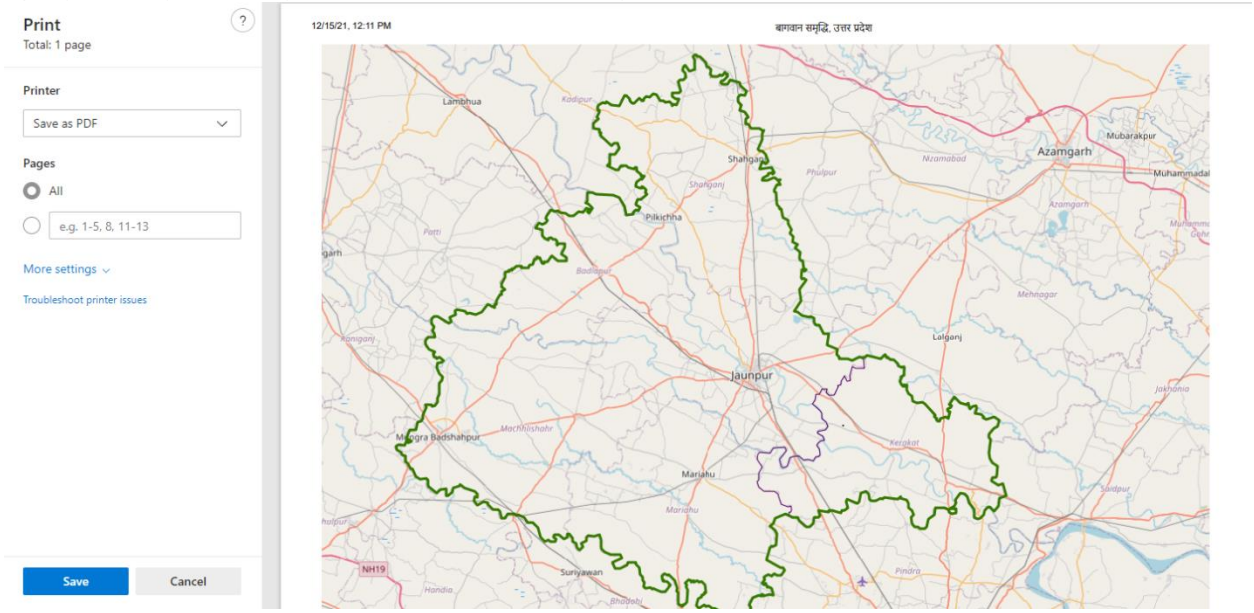

Fig:3(j)

Conclusion: In the end, we came to the conclusion that the problem which had remained so far was solved by this means. We have been successful in working according to the intention of the Government of India, so that a common platform was given to both the farmers and the buyer and they would get better profits.

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