

A Prototype of Cloud Based E_ Agriculture

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Abstract - Cloud computing is based on resource sharing in the large scale distributed environment. Its primary objective is to achieve the cost effective and eco-friendly computing environment. Cloud computing has been widely applicable in the field of agriculture in India. It can make available databases of numerous agriculture related information such as crop related information, weather information, soil information, growth progress monitoring, farmer data and expert consultation, wireless sensor network captured data, irrigation method, estimated yield report, pesticide and fertilizer knowledge, market price etc. Yet, there is a lack of interfacing between farmers and Information Technologies particular in the Punjab state of India. Agriculture information about new technologies and techniques are not provided to every farmer. This paper presents a cloud based prototype of e_Agriculture to provide the information directly to the farmers. The architecture and flow of data is discussed in the paper. Android Based Interface through mobile App used in the prototype is also described in the paper.

Keywords- Cloud computing in agriculture, e_Agriculture, cloud based agriculture infrastructure

I. INTRODUCTION

Cloud computing is a model to facilitate the convenient, ubiquitous, required network access to a shared pool of configurable computing resources such as servers, networks, applications, storage and services. These resources can be rapidly provisioned and released with minimal management effort or service provider interaction [1]. It provides enormous computing resources to the user applications through the internet in the large-scale distributed computing environment. Cloud computing is primarily characterized by multitenancy, fast deployment, low cost, scalability, rapid provisioning, elasticity and ubiquitous network access [2]. Further, the large volume of data can be stored in the cloud which can be accessed whenever and wherever required. Cloud computing has inherently flexible architecture as the resources are made available on demand and on need basis [3]. Cloud computing has the widespread applicability in industry, home applications, health monitoring, smart cities etc. It also has large scale contributions for the farming community to obtain information about the farming processes. For example, to check soil types and deficiencies, crops information, seeds

varieties, pesticides cycles, weather forecasts etc. [4] Furthermore, cloud computing is playing a key role in marketing, selling and policy framing among the farming community. It facilitates the farming community to get the advice of agriculture expert to solve any problem related to agriculture. On basis of the weather report telecasted through smart media, plant growth time can be better planned and market price is decided to choose the marketplace for sale the production [5]. It provides stored e-data to the farmers whenever and wherever they required and provide the agricultural expert advice to the farmers when they have any query related to the farming [6]. It gives the information about new technologies and machinery introduced in agriculture field. Farmers are directly connected to the operation by the cloud for sharing their experience by information sharing and communication [7]. Hence, it contributes to the overall agriculture production on the national level. Although cloud has enormous applications and contributions in farming but still there are various deficiencies in getting and accessing the appropriate farming related information by the farmers and other stake holders that affects the agriculture in Punjab state. The information related to agriculture required by a farmer is not readily available. Sometimes, flood and drought damage all the harvest due to the unawareness about weather change. Sometimes due to unawareness about the relative market pricing farmers sell their crops at low prices. Lot of efforts are being made at different levels by the state Govt. and various other private/public bodies for guiding the farmers about adopting the new technologies, machinery, and methods in farming, but still the entire farming community is not aware of all these advancements in the agriculture. Such information can be made available to farmers by the agriculture experts and may be made readily and easily available through the use of cloud based infrastructure. Therefore, information lacking in agriculture can be prevented using cloud computing [8]. Cloud computing provides various agricultural databases such as weather service, soil data database, experiment data database, market price, agriculture production condition database, crop model database and decision-making rules database, etc. [9]. Cloud computing in agriculture is exploiting many electronic and information technologies to fulfill the information needs of the farmers. For example, in China, "Tianfu Agriculture Information Network" is used to grow the rural mobile communication market [10]. It sets up internet

information stations located in villages and towns and makes available the SMS (short message service) facility, through which experts' advice from the information center and information personnel related to agricultural technology, products and meteorology is delivered to the farmers. In Canada, MobiCrop application makes the farmers aware about the pesticides which can be useful for a particular crop [11]. In Bangladesh, e-Krishok technology is developed for both farming activities and selling the products [12]. In e-Krishok whenever farmers face any problem in agriculture they are facilitated to send requests in the form of queries to the ICT enabled information centers through their own mobile phones and the needed information is provided back to them. In this paper a cloud based prototype of e_Agriculture is presented for smart agriculture based on cloud computing. The primary objective is the development of the cloud based e_Agriculture infrastructure. An android app named 'Punjab Kisan' is developed to provide the agriculture-related information to farmers in the e_Agriculture. In the e_Agriculture information is collected from different information domains in Punjab state and is further stored in the cloud environment for dissemination to the farmers for their use as and when required through mobile app. Rest of the paper is organized as. Section 2 presents the detailed architecture of e_Agriculture. Flow of data in the prototype is described in section 3. A brief discussion on the prototype is presented in section 4. Section 5 concludes the work.

II. PROPOSED PROTOTYPE OF CLOUD BASED e_AGRICULTURE

This section presents the prototype of cloud based e_Agriculture to solve agriculture related problems of the farmers in Punjab state arising out of appropriate information lacking. This prototype provides the communication linkage to the agriculture expert, policies announced by the Government related to agriculture and new technologies and techniques implemented in farming. Farmer are linked to the Android-based app as a customer/producer, for seeking assistance etc. Farmer as a customer can get the required information about fertilizers, pesticides, machinery, seeds etc. Such type of information will be provided through central datacenter on cloud. Data is generated on the centralized data center through different agriculture information domains such as Punjab Agriculture Department, Punjab Agriculture University, Punjab State Agriculture Marketing Board and Krishi Vigyan Kendras etc. Punjab State Agricultural Marketing provides the online detail of price and arrivals of the crops that should be grown in the Punjab state. Besides this, the information related to climate, quality seeds, irrigation time, diseases knowledge, suitable pesticides, and fertilizer also provided to the farmer. Punjab Agriculture University is an online medium to provide farming related information as crops, farm machinery,

processing machine, vegetables, fruits, flowers, organic farming, seeds etc. It checks the soil and water type of the land by testing the sodic soil and salty water. So that farmers can take a decision in growing the crops and save the crops from damage. Krishi Vigyan Kendras (KVKs) organized training programs for the farmers. These training programs are related to new agricultural technologies and techniques introduced in the farming management techniques and appropriate fertilizer and pesticides. Government policies announced by the Punjab State Government provide by Punjab Agriculture Department.

1) ARCHITECTURE OF CLOUD BASED PROTOTYPE OF e_AGRICULTURE

e_Agriculture. Layered architecture is proposed for the prototype model as shown in the Figure 1 to divide the functionality in layers. Three layers are used in the architecture. Cloud service provider is at the lowest layer which is responsible for providing the cloud based storage and processing facility. Above cloud service provider is the internet service provider layer which is responsible for providing internet (wide area network) functionality for connecting users to the stored information in a cloud environment. At the top is the user application layer which is responsible to provide information accessing capability to the end users. Android app executed on the smart mobile set/computer is created in this layer to access and seek the necessary information from the cloud based storage. The mobile app uses a PHP script to fetch data from MySQL database created in the data center in the cloud. All the data is stored in MySQL database. The android fetches the data and encodes it in JavaScript Object Notation (JSON) format to display in android device. Through mobile app new opportunities are open for rural farmers that have limited access to agriculture information like market, weather and crop diseases etc. Moreover, agricultural experts and government extension workers help to overcome from some of the hurdles faced by the farmers. Farmer registration detail is written through a PHP script and HTTP client-server APIs into a MySQL database at a remote central server. Farmers can seek the assistance of Android based app throughout the farming cycle. 'Punjab Kisan', the mobile app connects the farmer to cloud through internet. Cloud storage provides the agriculture related information to farming community which is stored at the cloud database. A disk array contains multiple disk drives store data in the data center. A redundant array of independent disks (RAID) enables fault tolerance and distributes data across multiple drives. Virtualization is also the concept of disk arrays which provides additional functionality by optimizing us of storage. Figure 1 presents the architecture of prototype of cloud based.

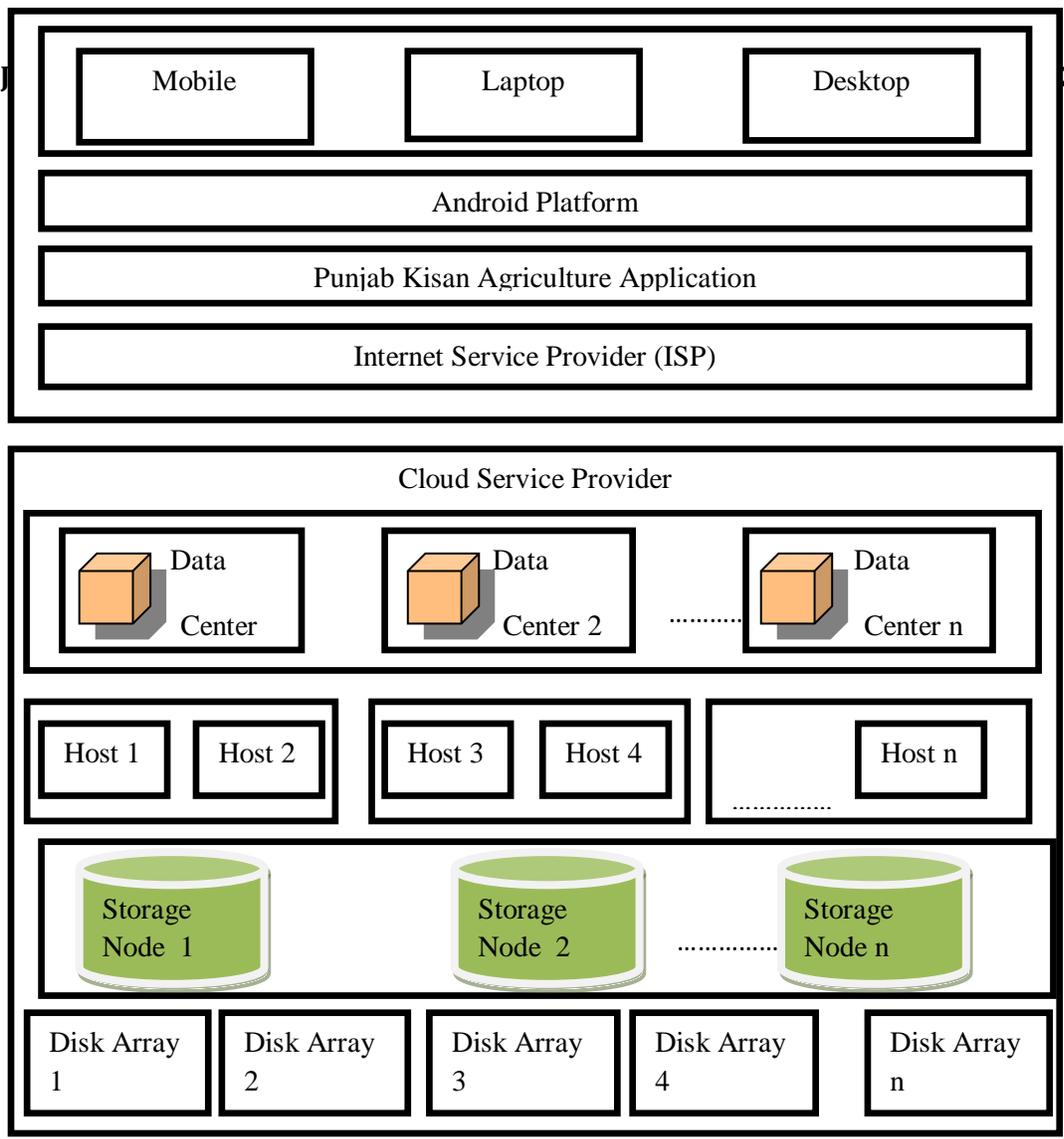


Fig. 1: Architecture of cloud based prototype of e_Agriculture

2) FLOW OF DATA IN THE PROPOSED PROTOTYPE MODEL

Figure 2 presents the data flow diagram to describe the flow of data between different components of the prototype. Prototype presents the association of physical components such as the users, mobile app, internet, cloud based e-infrastructure and information domains. In the proposed prototype model data flow is bidirectional between its components as:

users ↔ data store and
data stores ↔ information domains.

Following are the participant components in the presented prototype

- Users (farmers and other stake holders)
- Mobile app

- Internet
- Cloud based storage
- Information domain

A.USERS: The user can be a farmer or some other stake holders. Users can access agriculture data as well as upload their farming experience on the cloud database. Farmers can take appropriate decision to manage their farm by checking the soil condition, weather forecasting, monitoring plant diseases, prevention from pests, suitable fertilizer and better quality seeds etc through the presented prototype of e_Agriculture. They can also ask any query from agriculture expert related to the problems facing in farming. Market price helps the farmer to selling their harvest at actual price. For the stake holders, invention of new technologies and

machinery and uploaded videos on farmers experience are

beneficial to increase the knowledge.

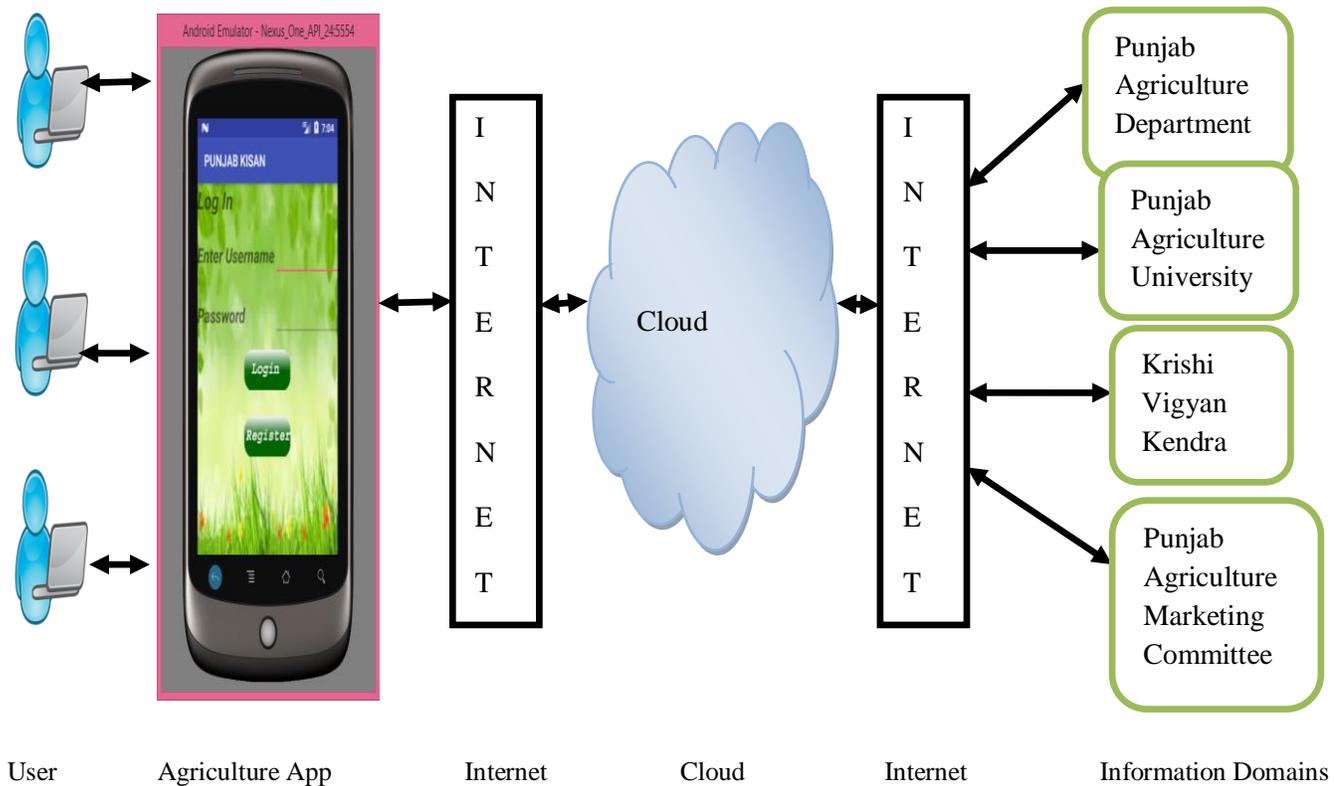


Fig.2: Data flow diagram of cloud based prototype of e_Agriculture

B. MOBILE APP: The mobile app is an interface between user and information domains. It is a medium to provide the data in farmers understandable language. Various facilities are available on one platform like recent trends in agriculture, government policies, marketing price, particular crop information, nearest agriculture equipment stores, agriculture expert advice, weather forecasting etc. Hence, it escape the time and money to seeking the different information on deifferent platforms. Its user friendly environment allows the farmers to operate in simple way by easily installing the app on their smart phones. Android based interface in the form of a mobile app ‘Punjab Kisan’ is developed in android studio software with the frontend of java and backend of MySQL. Android is an operating system developed by Google [13]. It is a software platform managed the coding in the Java language. The Secure Sockets Layer and Transport Layer are the protocols that secure the android studio from the attackers. Further, in app development android provide security through permission restricted access model which authenticate the user before access the app [14]. Java virtual machine converts the

Java source code into machine code [15]. MySQL is a database management system with platform independence. It handles many data types and provides thread-based memory allocation. It is a database server that delivers data to many clients [16]. MySQL provides cloud services and big data to access data directly from database cloud [17]. Moreover, MySQL cluster scaled the web database to manage the data online. PHP is a scripting language mainly used to design web pages. PHP is supported by all Web servers. For server-side execution, PHP code is embedded within HTML pages. Its main task is to extract data from database for web server to present on web page [18]. ‘Punjab Kisan’ mainly have eight options i.e. weather, best price, crop information, call now, dealer, expert advice, online help, and videos.

(i) WEATHER: Punjab Kisan app provide information about weather forecasting of the. It helps the farmers to take decision for various farming activities like sowing, irrigation, fertilization and harvesting. Farmers can avoid the unsuited irrigation, postponed the seed sowing and proponed the

harvesting taking into account the weather information. As per Figure 3, weather option of Punjab Kisan app is easily understandable by the farmers. Further, Indian agriculture is



Fig. 3: Weather Forecast Display on Punjab Kisan app

(ii) BEST PRICE: Punjab Kisan app has an option of Best price that deliver the market price of selected crop across the markets. It facilitates the farmers in a great way because farmers are generally uninformed about the actual price of crop across the markets. In this matter they are dependent on mouth to mouth transferred information. Therefore, they sell their crops through agencies. Through 'Punjab Kisan' price of selected crop is supplied according to the chosen mandi and district name of the farmer.

dependent on climate and it can be changed any time. Hence, the knowing weather reports in advance increase the agriculture yield and save crops from diseases and weeds.

(iii) CROP INFORMATION:

Punjab Kisan app has an option of Crop Information. It gives all information regarding any crop. Crop season tell about the season suitable to grow the crop. Government always announce crop price at the beginning of season. This app displays the price of crop so that farmers can take decision from economy point of view. The seed quantity for defined land is suggested and estimated yield from that crop is displayed on the screen as shown in Figure 4. The soil type that is required to grow the crop is tested before sowing the crop. Temperature necessary for crop mentions in the crop information option. Requisite resources for the selected crop are checked out if these are available and affordable or not.

(iv) CALL NOW:

Call now option in app gives the opportunity to farmers to connect to the Kisan Call Centre. It helps the farmer to ask any query related to agriculture and answers are given by agriculture experts. Immediately answer is delivered to the farmer by agriculture expert. If farmers are facing some problem they can ask through call now option from agriculture expert.



(v) DEALER:

Punjab Kisan app delivers the information regarding company and store names for purchasing seeds, pesticides, fertilizer and machinery. Data is stored as district wise and block wise that display the dealer name and address with contact number. Punjab Kisan app helps the farmer to detect the store address in their district. Farmers select their district name and the name of material to purchase. This app helps the farmers to directly contact and purchase the agricultural material from an authorized and authenticated. Hence, they do not face any frustration to seek the store address of suggested

seed, pesticide and fertilizer. The new machinery implemented in agriculture is easily detected which may available at limited stores.

subsidies and policies. Information about new implemented techniques and machineries introduced in agriculture are uploaded at farmer portal. Hence, farmers can get aware about all of these.



Fig.4: Crop Information display on Punjab Kisan App

(vi) EXPERT ADVICE:

Punjab Kisan App provides agriculture expert advice to solve the problems faced by farmers. Farmers can ask any query related to farming for example sowing time, irrigation method, pesticides, fertilizers, seed quality and quantity etc. A list of agriculture expert names is display in the drop-down list. After selection of particular agriculture expert name, a query will be typed in the text box as shown in Figure 5. Agriculture expert post the appropriate solution of asked query along with date and time. It helps farmers to take decision in farming. Farmers can prevent their crops from diseases attack and damage of plant growth. Expert advice option solves the problems that are not handled by farmers at their own level.

(vii) ONLINE HELP:

Punjab Kisan app has the option of online connectivity to the farmer portal available at Punjab Agriculture University website. It provides information related to soil test, water test, irrigation system, fertilizer, information regarding vegetables and fruits etc. Farmers can check the condition of sodic soil and salty water of their land. Besides this the policies announced by government, Kisan Melas dates, subsidies provide by government, new technologies and techniques in agriculture, agriculture sensor information etc are presented at the farmer portal. By getting the information farmers can attend the Kisan Melas and take the benefit of government

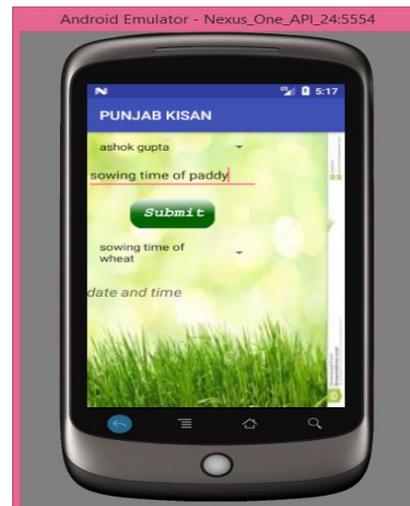


Fig. 5: Asking Farming Query from Agriculture Expert

(viii) VIDEOS:

Video option available at Punjab Kisan app allows the farmer to upload videos of farming based on implementation of new techniques, new machinery, agriculture sensor working, disease information etc. Videos can also be uploaded by the agriculture experts to introduce the new machinery, techniques and technologies in agriculture sector for farmers. These videos help the farmers by viewing online farming techniques and they can easily adopted new farming methods and machineries. Uploaded videos are stored in the database of Punjab Kisan app so that farmers can view videos whenever they require.

C. INTERNET: Internet make access the mobile app for users. It connects the mobile app to cloud and cloud to agriculture information domains. Internet is the way to access online agriculture data. Farmers can also upload their farming experience on agriculture cloud through Internet. Farmers can post their agriculture query through Internet and agriculture experts replies the query in same manner.

D. CLOUD BASED STORAGE: Cloud data centers store the agricultural data in the background. Data is integrated from different agriculture information domains in Punjab state for storing in the data center. Cloud based storage store data related to good quality seed, sowing time, irrigation time, fertilizer, pesticides, crop diseases, market price etc. Farmers can access the required data from cloud through mobile app, 'Punjab Kisan'. Main objective of cloud based storage is real time loading, storage and processing of different type of agricultre data. Stored data can be linked to other data.

E. AGRICULTURE INFORMATION DOMAINS: Various agricultural information domains such as Punajb Agriculture Department, Punjab Agriculture University, Punjab Agriculture Marketing and Krishi Vigyan Kendra are available which provide the agriculture information on every farming stage. These infromation domains provide the all information about seasonal crops.

III. RELATED WORK

Many smartphone applications are developed for the agriculture such as appagro, agroIndia, Agriapp, PusaKrishi etc. Appagro is an agriculture-based android app. It has seven options in the main menu as DEMO, TEST, RICE, Monitoring, Tillage, Harvest and Synchronize, Test, Rice, Demo and monitoring option provide the information regarding insects, diseases, weeds, additional data, and phenology [19]. The information is provided about the particular selected crop. Further, the tillage option delivered the knowledge of sowing, harvest, selected equipment and unit. The information about equipment necessitated for sowing and harvesting supplied to the farmers. It also has the options to send data, update device, check monitoring, check tillage, check harvest. Another agriculture app 'Pusha Krishi' is launched by the government department of agriculture [20]. Pusa Krishi has four options i.e. varieties, production technology and equipment & implements. The varieties have further sub-options of cereals, fruits, oilseeds, pulses, vegetables. In the production technology input resources such as biofertilizer, decision support system and management are available. Production technology option has Biopesticides, Diagnostic Kit, Insect Rearing Diet and Pesticide options that provide the knowledge about appropriate pesticide for the crop. Further, the Equipment and implements option has animal feed making machines, machinery for vegetable

mechanization, machines for compost making, mechanization for cereal crops, mechanization for rain-fed agriculture, safety and comfort of agricultural workers and solar power system. These options supply the information related to new machinery introduced in agriculture field to increase the yield and save the cost and time that spend on the laborer for sowing and harvesting.

'Agro India' is also an agriculture-based app which has the options of agro information, other information, exhibition, agro market, shop online, imp mobile apps [21]. Agro information delivers the information related to agriculture security, agro information, agro news, agro-technology, crop information, dealer & distributor, fertilizer info, pashu, plant protection, pvc and plastic, government subsidy & scheme, a success story. Other information option gives the knowledge about agriculture loan and banking facilities. The exhibition option provides the detail of organized exhibition on machinery and vegetables. Agro market has agro news of latest news about agriculture and government policies. Farmers can purchase the agriculture machinery through shop online. It also connects to other apps by clicking the imp mobile app.

'Agri App' is an agriculture-based android app that has four options which are a package of practices, chat with an expert, videos, and news [22]. It has also a Buy Now option that provides a suitable name for biofertilizer, crop tonics, organic fertilizer, NPK fertilizer, specialty fertilizer, insecticides, fungicides, weedicides, seeds, equipment and bulk input. So that farmer can purchase an appropriate spray for their crop. Moreover, a package of practices gives the crop detail related to given crops. Chat with expert option connects the farmer to an agriculture expert that gives an answer to the query sent by the farmer. Further, videos options have various videos related to farming, uploaded by admin or agriculture experts. It gives information of farming method through the videos. Next news options display the selected crop information like required soil type, sowing time, water type, fertilizer and pesticides required.

IV. DISCUSSION & CONCLUSION

Farmers are facing various problems in agriculture that may not be solved by them or their peers. For example, crop disease, seed quantity, new technology-based machinery, sowing method, harvesting etc. in these situation farmers require advice given by agriculture experts. Although existing apps make available many services to the farmers, yet these have many limitations. These do not provide weather forecasting, market price of crops to the farmers. Lack the knowledge of stores information for purchasing seed, pesticide, fertilizer, and machinery is another limitation of these services. Further the agriculture expert advice is not accessible through these services. Online Help for soil and water testing of farm land is also not available in these

services. Hence, a cloud-based prototype of e_Agriculture is proposed to overcome from the limitations in already implemented agriculture based android apps and services. 'Punjab Kisan' app for agriculture is providing agriculture information quickly and according to the requirements of the farmers. 'Punjab Kisan' app is designed keeping in mind the real problems faced by farmers of Punjab in the aspects of insufficient and appropriate agriculture information to them.

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