# Video Cloud Based Agriculture Extension For Global Poverty Alleviation

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***Abstract:*** **This research paper propounds a solution for the poverty alleviation program all over the globe by use of technology for increasing the agriculture related output. 820 million people out of the world population of 7.35 billion remain chronically hungry and don't have enough food to lead a healthy life. One third of the hungry people live in India and they survive on less than half a dollar per day. Agriculture is the main source of employment, livelihood and income for between 50% - 90% of the population. In developing countries, small farmers with low literacy account for 70% to 95%. These farmers are engaged in cultivating the soil, growing crops and raising livestock and are mostly poor. UN Member States adopted the Agenda for Sustainable Development, which includes to end poverty, fight inequality and injustice, and tackle climate change by 2030. These goals are formidable unless the knowledge, skill and attitude of framers are enhanced and they are motivated to use the newer methods and technology to increase the food production. Video Cloud based agriculture extension coupled with smartphone is a great solution to address the problems of over 1000 million farmers residing in developing countries around the globe. The solution is discussed in this paper.**

***Index Terms*** **- Poverty Alleviation, Agriculture Extension, Sustainable Development Goal, Video Cloud, Smartphone.**

## I. INTRODUCTION

Agriculture is the art and science of cultivating the soil, growing crops and raising livestock. The profession includes horticulture, floriculture, animal husbandry, forestry and allied works. Agriculture includes such forms of cultivation as hydroponics (growing of plants in a soil less medium, or an aquatic based environment) and aquaculture (farming of fish, crustaceans, molluscs, aquatic plants, algae, and other aquatic organisms). Both involve farming in water. Agriculture is the basis of human civilization on earth that started about 12,000 years ago. The earliest civilizations based on intensive agriculture arose near the Tigris and Euphrates Rivers in Mesopotamia (now Iraq and Iran) and along the Nile River in Egypt. As the Romans expanded their empire, they wrote manuals about the farming techniques and adapted the best agricultural methods of the people they conquered, in Europe. The history of Agriculture in India dates to Indus Valley Civilization Era (4500 BCE) and even before that in some parts of Southern India (9000 BC). As the civilization and population grew, newer techniques were used for higher yield. Over time, improved farming tools of bone, stone, bronze, and iron along with storage methods were developed. The story of development of agricultural processes is a saga of development of human civilization. To name a few these were, development of irrigation system (Mesopotamia-5500BCE), open-field system of planting (medieval Europe-2000 years ago), horse-drawn seed drill (England-1674), crop rotation methods (USA-1860), fertilizer using nitrogen, phosphorus, and potassium (America and Europe- 19$^{th}$ century) and many more. Later, During the 1950s and 1960s, scientists developed new strains of high-yield wheat and rice resulting in increased yield known as green revolution. However, the new strains required chemical fertilizers, pesticides and irrigation. The knowledge of genetic engineering also led to the selective breeding process in both plants and animals. These genetically modified organisms (GMOs or GM foods) have opened new vistas such as transgenic plants that resist certain pesticides and herbicides allowing the use of toxic chemicals. Biotechnology has brought advances in animal husbandry. Many cattle are also given anabolic steroids, or growth hormones, to make them get bigger, faster.

Agriculture sector employs over one billion people in the world which includes 60 percent of all child labourers – 129 million girls and boys [1]. More than two-thirds of children are unpaid family members. Poverty is the principal driver of the high rate of child labour in agriculture. The average share of agriculture in world's GDP is 12.09% as in 2015, with India on 17.46% and African countries like Ethiopia and Sudan about 39% [2]. There are more than 570 million farms in the world with 85% less than 2 ha [3]. More than 90% of farms are run by an individual or a family and rely primarily on family labour. A large portion of the world's agricultural land is occupied by family farms which produces about 80% of the world's food. Developing countries in Africa, Asia, and Latin America are the habitat of the most of the world's farmers. These people with about one-acre land are subsistence farmers. Agricultural methods often vary widely around the region, depending on climate, terrain, traditions, and available technology. The countries also differ greatly in their systems of governance and economic management. However, most of them cultivate land as their ancestors did hundreds or even thousands of years ago. They do not use agricultural technology involving expensive chemicals or production methods. Farming requires an array of skills: farmers must know when to plant and harvest and what types of crops to rotate, understand soil types and their limitations, when to apply man-made or organic pesticides and fertilizers, and be able to harvest and market their produce profitably. Generally, the supply to marketing chain is long with lot

of middle men who pocket a substantial profit leaving the farmer always poor. In developing countries, small farmers cannot afford the new technology and big business has taken over agriculture.

Food production must keep pace with the population growth in the country. The problem is uneven distribution of food. There are countries in the world who have surplus food with low population. Contrary to this, there are countries with higher population rise, low literacy, absence of knowledge of new technology resulting in hunger and poverty. The number of hungry humans has reached the 1 billion mark in the world. According to estimates, small farmers in South Asia and sub-Saharan Africa can increase their crop yields in the next 20 years, translating into roughly 400 million people lifting themselves out of poverty [4]. This is possible only if the farmers are provided sustained technology assisted knowledge, skill and aptitude along with monetary support from State and not the dole or credit waiver frequently resorted by Governments of the land.

## II. Literature Review

The role of agriculture in economic development and poverty reduction has attracted the attention of economists in both the developing and developed countries. Many economists attributed the lower contribution of agriculture revenue to GDP as a sign to the economic progress due to higher consumption of manufactured goods and services. However, this theory has a paradox since the basic producer of the primary ingredient, the farmers remain poor and deprived [5], [6], [7]. It is historically known that there is close correlation between poverty reduction and growth of agricultural productivity [8]. Bresciani and Valdes used a theoretical framework to conclude that when both the direct and indirect components of agricultural growth including 1) labour market, 2) farm income, and 3) food prices, are accounted, such growth is more poverty reducing than growth in nonagricultural sectors [9]. Studies have established that growth originating in agriculture is on average significantly more poverty reducing than growth originating outside agriculture [10]. In a study for China, it was established that agricultural growth had four times greater impact on poverty reduction than growth in the secondary and tertiary sectors {11}. A study by OECD of twenty-five selected countries in the world showed that over one-half the reductions in poverty was due to growth in agricultural incomes, over one-third to growth in remittances and only just over 10% due to growth in non-farm incomes [12].

The greatest global challenge is to eradicate poverty in all its forms which is a crucial requirement for sustainable development. United Nation has set Sustainable Development Goals (SDG) to end poverty and hunger everywhere and create conditions for sustainable, inclusive and sustained economic growth, shared prosperity and decent work for all around the globe by 2030 [13]. It is a tall task to achieve food security as a matter of priority and to end all forms of hunger and malnutrition. This will need Governments to build dynamic, sustainable, innovative and farmer-centered economies, promoting youth and women's economic empowerment. It shall need well-educated workforce with the scientific, technological and innovative capacities, knowledge and skills for enhancing the farm yield with the use of correct technology and practices. The present world population of 7.3 billion is expected to become 8.5 billion by 2030 as per UN projections [14]. The end of poverty and reduction in undernourishment and child stunting will require 35% increase from present 20% in food production and 4.5% income growth per year as against the present rate of 2% for small farmers in poorer countries [15]. To achieve this, Climate-Smart Agriculture (CSA) focusing on three outcomes namely, increased productivity, enhanced resilience, and lower emission will have to be adapted. Good soil management, climate-smart water management, agriculture information systems, agriculture risk management tools and policies to target sector development are the basic ingredients to achieve this target.

World Health Organization (WHO) defines GMO as “Organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination” [16]. A section of people thought this as a solution to the world’s hunger problem. However, GM products have also earned lot of controversy. Many people feel that GM foods have less nutritional value and decrease biodiversity. The organic "free-range" food industries have grown in opposition to "factory farming". In 2000, a coalition of biotech companies namely, Monsanto, Dow Chemical, DuPont, Swiss-based Novartis, the British Zeneca, Germany’s BASF and Aventis of France began a $50 million media campaign to allay fears about genetically altered foods and pitched it as “solutions that could improve our world tomorrow” and could help end world hunger. But delegates from 18 African countries at a meeting of the UN Food and Agriculture Organization responded to Monsanto’s advertisements with a clear statement: “We... strongly object that the image of the poor and hungry from our countries is being used by giant multinational corporations to push a technology that is neither safe, environmentally friendly, nor economically beneficial to us. We do not believe that such companies or gene technologies will help our farmers to produce the food that is needed... On the contrary... it will undermine our capacity to feed ourselves” [17].

The discussions in preceding paras make it very clear that agriculture is no more a practice of cultivating land as was being done by our ancestors. It has evolved to the level where a farmer needs the necessary knowledge and skill to make improved choice right from cultivating his land to marketing his products gainfully. Within this environment of uncertainty, farmers must make choices of the combinations of crop and livestock products to produce, the farm practices and resource mixes to deploy, the scale of operations and investment and other decisions which lead to profits or losses. He needs to foresee the demand of a produce, availability of seeds, biophysical constraints such as low and uncertain rainfall, steep slopes, or poor soils, socio-economic constraints such as poor access to markets and infrastructure (or both). Most of the small farmers in poor countries have no access to the information and they continue to be poor and excluded. States need to play a measure role to train them and assist them in making them a partner of growth and economic prosperity.

## III. TECHNOLOGY ASSISTED AGRICULTURE EXTENSION

Government extension agencies are often bureaucratic and the services they provide don't reach all smallholder farmers nor provide up-to-date and tailored information to meet the needs of the farmers [18]. The increasing complexity of farming – all the decisions that farmers need to make about land use, the selection of food and commodity crops, the growing diversity of farming systems, the markets they access –and the rising request by farmers for knowledge and information, has resulted in the traditional system of extension irrelevant. In this scenario, extension workers in developing countries have used various methods for disseminating knowledge through radio programmes, videos and other ICT-based methods during last two decades [19]. This enabled the extension services to reach large number of farmers located sparsely in rural areas as compared to the traditional extension system which reaches only to 10% or less population. Radio is a useful economic tool for sending information to farmers in a specific area in his own language. It has been used by number of developing countries in Asia and Africa for agriculture extension. The constraints are difficulty in getting licenses from States, strict regulations, capitol cost for set up, sustainability after donor withdraws funding, its "audio only" medium and limited two-way interactivity [20]. Agricultural extension videos have been found to be an effective tool for accurate transmission of homogeneous information from a technical source to a low-literacy population. Being shown a video in which a fellow farmer or a scientist talked about the virtues of a range of modern techniques may serve as a visual and auditory cue for the information the farmer already possessed. However, knowledge to farmer increases when a technical expert or high-quality trainer is available to explain. This means presence of an expert to different locations with the equipment and video that becomes too expensive. Text messages in form of SMS have also been used by many extension practitioners [21].

## IV. VIDEO CLOUD BASED EXTENSION

Videos are an indispensable part of the agricultural extension tool kit. Specific videos aimed at transferring narrow technical information to leverage knowledge farmers already possess but may not be confident enough to use, have been found very effective. In a pilot scheme implemented by World Development Foundation in India, it was found that crop and context specific videos showing more general information, such as the importance of nutrient management or general hygiene to combat pests and diseases, were well adapted by the farmers [22], [23]. In a study undertaken in Uganda, it was concluded that "videos may provide visual and auditory stimuli that lead to cognitive processes of schema abstraction and cued recall, which, in contrast with classic studying, has the potential to create new and longer-lasting connections between concepts" [24].

### 4.1 Components of Video Cloud based extension

The main components of our proposed systems are message and its creation and storage, delivery system and receiving system. Our message is in the form of video content, medium is of video cloud and receiving system is smartphone. Before we design and discuss the system architecture, we will discuss our choice of these components to build a futuristic agriculture extension system.

#### 4.1.1Video as message

According to McQuivey's Forrester study, "Video is worth 1.8 million words". His reasoning is simple: if "a picture is worth a thousand words, then a video has to be worth at least 1.8 million words" [25]. One study found that when images are paired with information, "people retain 65% of the information three days later, as opposed to just 10% with text alone" [26] Another study by Insivia found that "viewers retain 95% of a message when they watch it in a video, versus 10% via text" [27]. RSA-style animated videos can pack in a lot of information in a short time [28]. High quality, concise, informative explainer videos are incredibly valuable for training farming community. Video can communicate everything extension workers want to say into just a few seconds. As more people watch more video on mobile devices, video has become the default way to communicate information.

#### 4.1.2 Video cloud as medium for delivery

The term "cloud computing" was first used in 1996 to describe a computing model where all desktop applications live on the cloud. The cloud computing model was reintroduced in 2006. By 2009, Internet giants like amazon.com, google.com, microsoft.com, and IBM started using this computational model and started offering this facility to other web users [29]. The "cloud" is a metaphor for the Internet. Cloud computing, in turn, refers to sharing resources, software, and information via a network. As a user, the farmers access the stored information on the cloud via the Internet. Access is available from any location and by any device including laptops, tablets, or smartphones. The concept of video cloud storage, processing and delivery is shown in Fig. 1. The advantages of video cloud storage and delivery are summarized below.

- It cuts across culture, language, literacy and a lot of other issues that plague the distribution of digital content. The access can be countrywide or worldwide.
- The complexity of video cloud storage, computing and distribution is handled by service providers who are domain experts. This allows high level of reliability and scalability.
- There is a high level of interaction and flexibility in viewing as well as sharing.
- The convenience of accessing any content at any time anywhere is the key driver for online video consumption.
- Online video offers the best of traditional TV with extra benefits such as analytics, mass distribution and lower cost of implementation. The
- Content is available with automatic metadata and multiple language subtitles.
- Supports advertising models with automatic ads insertion server side.

- Construction of the State Archive with free ON DEMAND unlimited access to all content placed on the cloud.
- Content with single URL, using HTML5 advanced player instead of flash player which is very heavy.
- Adaptive Bitrate Streaming permits to deliver video for broad range of devices - mobile, tablet or OTT and varying network bandwidths. A live video cloud transcoding workflow is shown in Fig. 2.
- With AI-infused and cognitive technologies, Cloud Video empowers clients to improve every facet of on-demand and live video.
- The content can be received across multiple devices and networks such as
    - all Devices : Smartphones, Tablets, Feature phones, Smart TV, Android Set Top Boxes, Roku, Apple TV…
    - all Operating Systems : Android, iOS, Windows …
    - all Telco Networks

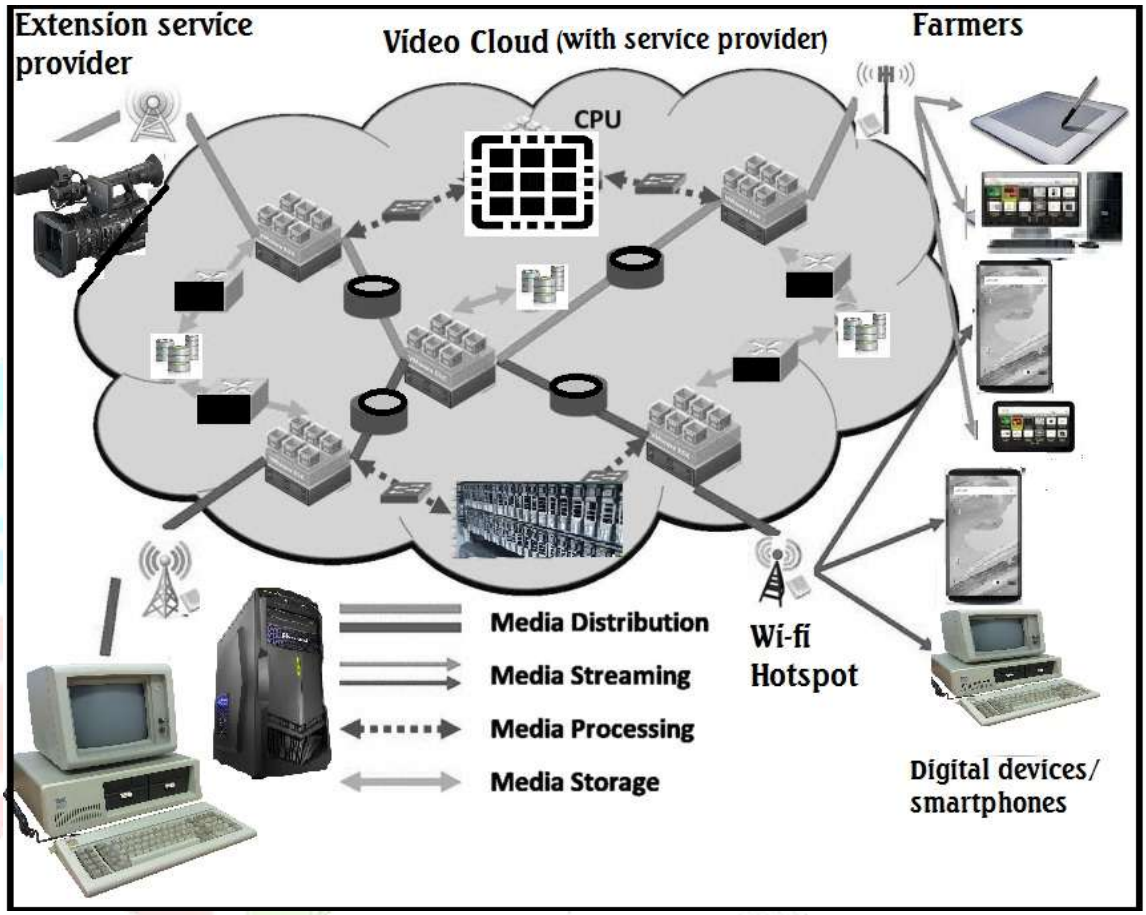


Fig.1 Concept of video cloud storage, processing and delivery

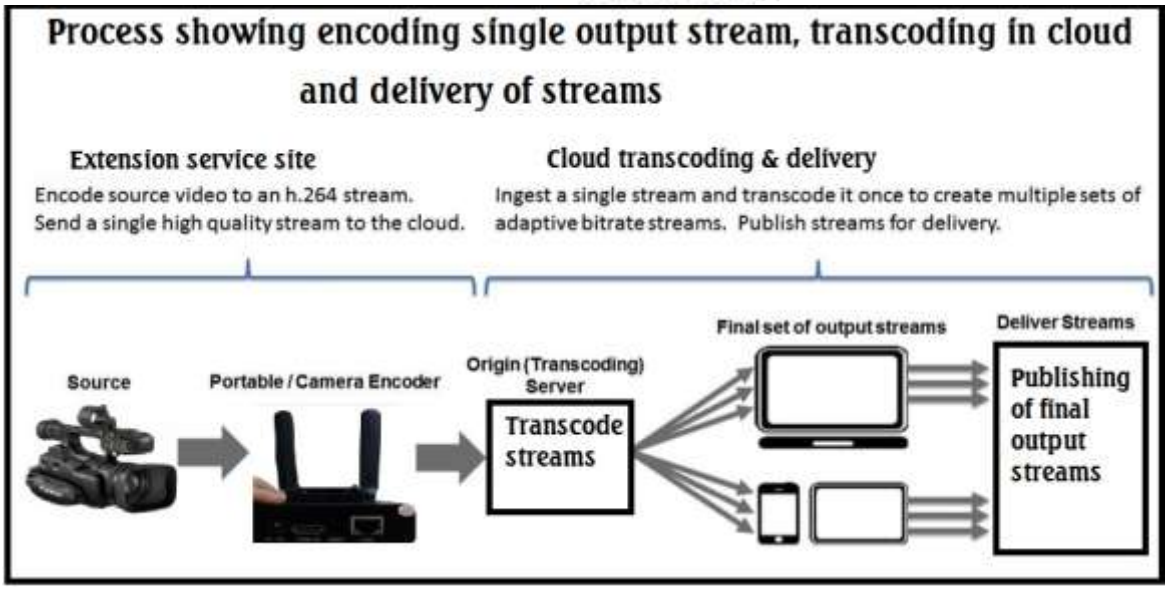


Fig. 2 Cloud Transcoding workflow

**4.1.3 Smartphone and digital devices as receiver**

The access to computers and the laptop is still a distant dream for poor and marginal farmers in most of developing countries. However, mobile phones growth in the entire world has been phenomenal. The International Telecommunication Union (ITU) data shows the subscriber growth exceeding 300% during the ten-year period in the developing countries (Table-4.1.3). In 2016, an estimated 4.3 billion (62.9 percent) population worldwide already owned a mobile phone which included 2.1billion smart phones. The number of mobile phone users is forecast to reach 5.07 billion by 2017 in the world [30]. In 2016 mobile video accounted for more than 50% of all online video views. Smartphones and digital connectivity can address the challenges of extension services. According to Granryd, "the near ubiquity of smartphones and high-speed connectivity is enabling innovation in areas such as artificial intelligence and driving the digital transformation" [31].

Table 4.1.3: Mobile telephone subscribers per region

| **Mobile telephone subscribers per 100 inhabitants** | **2005** | **2015** | **% increase** |
|---|---|---|---|
| Africa | 12.4 | 73.5 | 429.7 |
| Arab states | 26.8 | 108.2 | 303.7 |
| Asia and pacific | 22.6 | 91.6 | 305.3 |
| Europe | 91.7 | 120.6 | 31.5 |
| The Americas | 52.1 | 108.2 | 107.5 |

Source: ITU World Telecommunication/ICT Indicators database

**4.2 Functions needing integration**

Any system for addressing the farmers should integrate all functions; from providing advice and sharing knowledge to creating awareness, linking with other actors, and technology transfer. We list the functions that needs to be integrated in the design (Fig. 3). The information and knowledge on these with their metadata for easy access will be available on cloud.

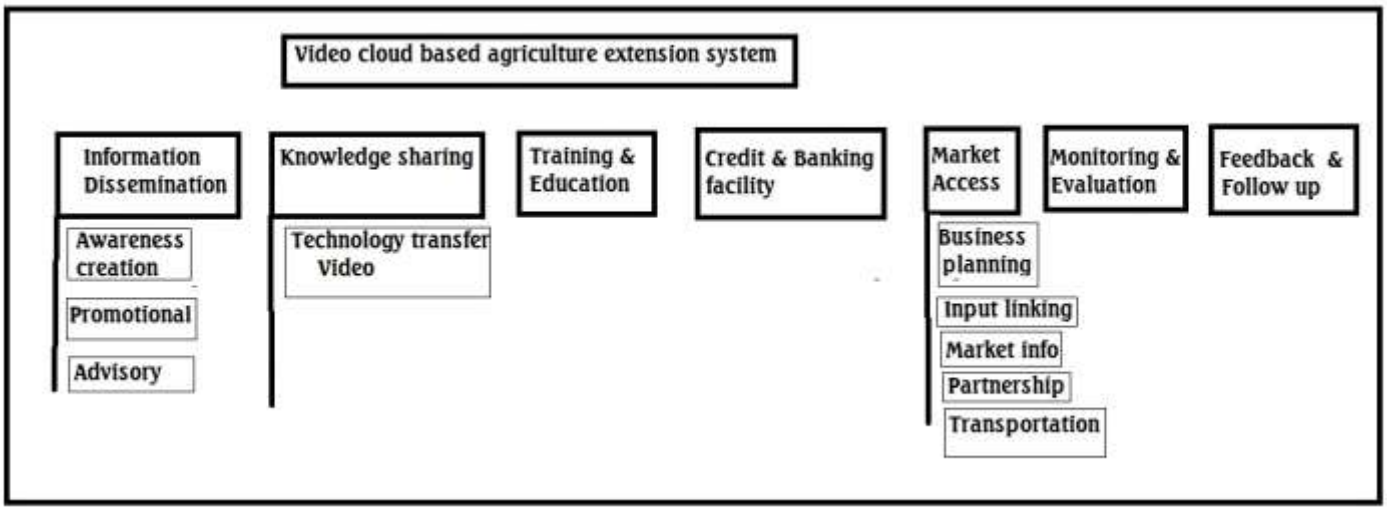


Fig. 3 Information-base on cloud

**V. SYSTEM ARCHITECTURE**

The system architecture of video cloud based agriculture extension system is given in Fig.4. The system consists of several production centers to prepare relevant videos for imparting knowledge and information to farmers located in different geographical locations. These videos are region specific to suit the soil and climate conditions. The videos and other media are placed on cloud. The farmers can watch the video and access the information from any location and using any digital device including his smartphone. The use of modern technological practices enhances his yield. The most important part of the system is his ability to connect to the end users and market his produce eliminating the middle men. This provides him higher income for his yield and enhances his power to procure better inputs for his next cycle apart from reducing his poverty.

There have been some efforts by Governments to create e-marketing websites for farmers to know the retail and wholesale prices of the commodity. However, the farmers are still not able to sell their products directly to the end users. In the system proposed, the farmer uses his smartphone as a device for direct negotiations with the end consumers. A linkage of the system directly with the marketing websites may be an effective proposition. This is more relevant for the States where organic farming has been adapted but still the farming community is not able to earn right price.

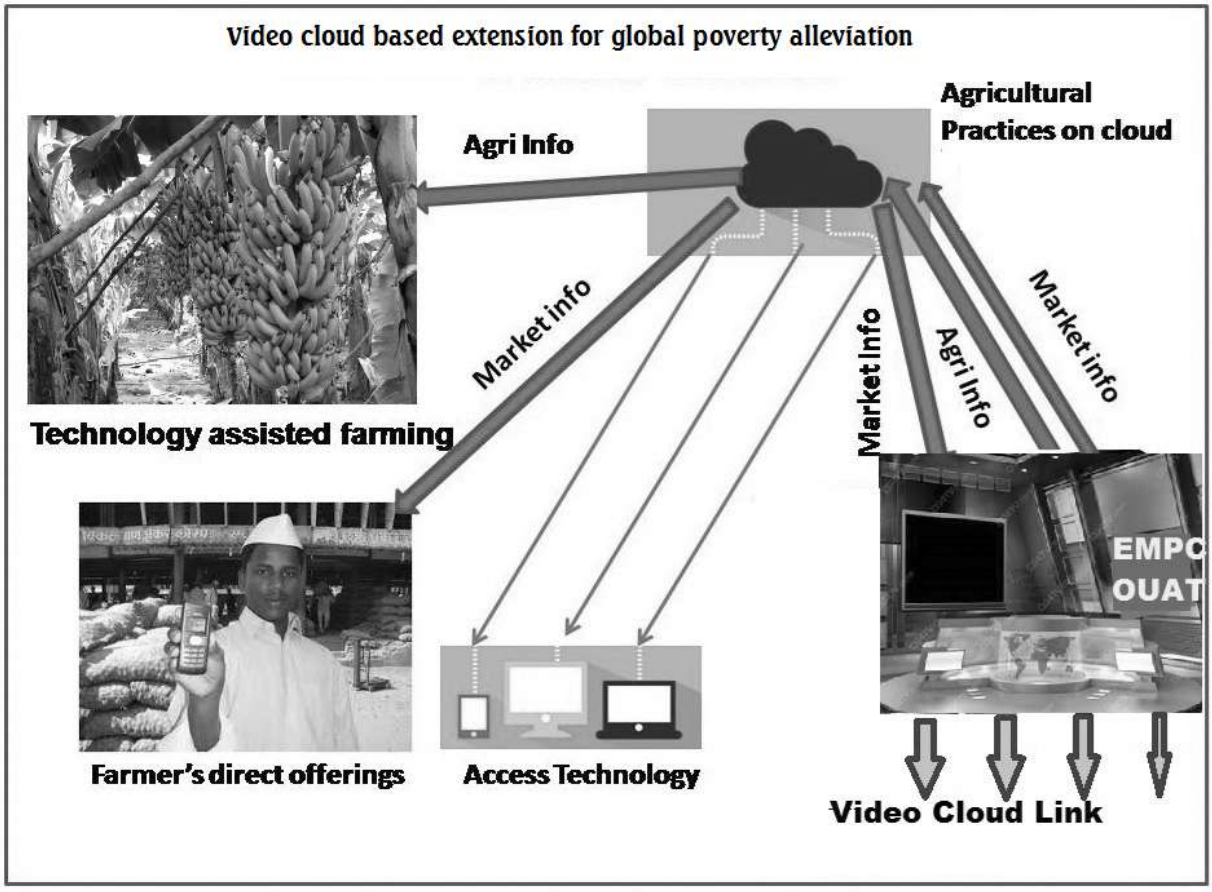


Fig. 4 System Architecture for video cloud based extension

Video Cloud is designed such that, it plays wonderfully on the mobile device, desktop, and connected TV, no matter the resolution, content, or connection speed. Video Cloud automatically transcodes the video into a collection of renditions, each suitable for viewers' bandwidth and resolution. Video Cloud dynamically detects the screen size and connection speed of the user's device and provides the right rendition to maximize quality based on the speed and power of the viewer's device. This is the property of the cloud system, computation and processing takes place in cloud and needs no user intervention. This is possible for live streaming also. The processes involved are as below.

- Assessment of the needs of the target community by conducting benchmark surveys.
- Engagement of several agencies production of localized and customized content.
- Deployment of content on video cloud platform and customization of ICT tools for browser integration etc.
- Sensitization of farming community on the presence of the services and how to access them.
- Partnerships with stakeholders present in the target area for integration of the services in the public agricultural extension system.
- Monitoring and adaptation
- Modifications
- Impact assessment

## VI. Discussion and Proposed Action Plan

Agricultural systems are remarkably diverse, with livestock, crops, climates, tools, soils, and technology varying from country to country and also even farm to farm. That is why, we have given our best to avoid any kind of generic prescriptions. One-size-fits-all solutions are unlikely to work and solutions will need to be tailored to address regional and site-specific needs. The video cloud technology has been used successfully in diverse areas. WhatsApp (one billion users) [32], Facebook (2.06 billion users) [33], YouTube (one billion user) [34], Bank of America, Merrill Corp., American Airlines are few of the successful users of the platform. The advantage of the platform is that it leaves the function of maintaining a huge data processing center to the video cloud service provider and allows agriculture scientists to focus on their expertise.

Francis and Addom [35] argue that extension alone cannot lift people out of poverty unless there is the right combination of policies, technologies, and market opportunities. We have proposed a sound and reliable technology. The States and Governments need to formulate the policies, allocate the resources and make available a just market to the farmers.

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