ICT Innovation in Disseminating Agriculture Information in 4 Village Development Committees of Gulmi District

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Abstract: The main objective of this research is to propose innovative framework for knowledge transfer and skill development on Agriculture Information Dissemination by implementing Information and Communication Technology (ICT) in 4 Village Development Committees in Gulmi District. A series of focus groups were planned with local communities, farmers' groups, public and private sector extension service providers, as well as local government agriculture agencies. The focus group discussions aimed to understand the problems faced by farmers, what information they needed and their view of the barriers to adapt new technologies. An agricultural productivity analysis in Gulmi district showed that cereal crops rice, wheat and maize were the major harvested crops. The advice of field assistants/agriculture officers in terms of agriculture information was considered more reliable along with the input from experiences of fellow farmers who had 'early adopted' agriculture advice. Farmer networks supports the building of larger mobile-based communities where farmers could benefit from the experience of farmers in their own or other villages. The research also indicates that the unaffordability of ICT equipment of farmers act as impediment in accessing ICT based information. This indicate the need of establishing ICT center dedicated to agriculture information dissemination and support capacity building as most of the farmers are unaware of what ICT can deliver. A Multi Criteria Decision Analysis, Analytic Hierarchy Process (AHP) was used to assess and prioritize Farmers' need with respect to criteria defined and technology alternatives were assessed. The farmers' experience with ICT tools and their need was also analyzed through field visits. Furthermore, a model for 'Agriculture Information Dissemination' where a 'Centralized Integrated Repository System' has been proposed which could be used as core for Web Based/SMS/IVR/USSD Services. The research also proposes Mobile Application (Android) along with sustainability of the Information Dissemination model.

Keywords: Information and Communication Technology (ICT), Innovation, Agriculture, Analytic Hierarchy Process (AHP), Gulmi

1. Introduction

Nepal is located between latitudes 26°22 N to 30°27'N and longitudes 80°4'E to 88°12'E in the Hindu Kush Himalaya Range of South Asia. Agriculture is the mainstay of the economy, providing livelihood for more than 80 percent of the population and accounting for some 40 percent of Gross Domestic Product (GDP). Administratively Nepal is divided into 75 districts. Physiographically, the country is divided into 5 regions: Terai, Siwalik, Middle Mountain, High Mountain, and High Himalaya. Terai is the main area where cereal crops can be extensively grown. Because of the tropical and sub-tropical climate in the region, food crops, vegetables and fruits of tropical and sub-tropical nature are the main agricultural products. As we go higher we have mid-hills where different types of crops can be grown. The Irrigated Crop Calendar for Nepal shows that Wheat, Maize and Rice (34%, 30% and 28% respectively) [1]. Rice-Wheat-System, one of the principle cropping systems in Nepal, occupies one-fourth of the total cropped area and provides food, income and employment to 83 % of the Nepalese populace. Thus, the rice-wheat system is of great importance in assuring food security and enhancing livelihood of the Nepalese people. Nepalese agriculture system and the cropping pattern are highly dominated by the geography and the culture. Rice-wheat, rice-legume, rice-wheat-maize, rice-wheat-rice are some of the most common cropping systems in Nepal. Cash crops have also been a major source of agriculture production in Nepal. Crops such as oilseeds, tobacco, jute, sugarcane and potato are generally considered as cash crops in Nepal. Other crops like green maize cobs are also accounted for cash crops in recent days.

2. Agriculture Productivity and Extension in Nepal

2.1 Agriculture Productivity

There has been an apparent decline in agricultural productivity in recent years in Nepal. Production of rice crop fell by 11 percent, Maize production also declined by 8 percent and wheat production increased by 2 percent in fiscal year 2012/13 than the previous year. The decline in agricultural productivity has been accounted for effect in weather (delayed monsoon rain), natural disaster (500 hectares of land were destroyed by inundation, river bank erosion and sand burial in 2012/13). Likewise, rice could not be planted

in an area of about 110,000 hectares of land due to less precipitation [2]. The number of agriculture households in Nepal is 38,31,000 which is 4.67 lakhs more than previous census year while the Agriculture holding area is 25.25 Lakhs Ha which is 1.29 Lakh Ha less than the previous census [3]. The table below shows the decline in production of major cereal crops in the last 10 years.

Table 1: Decrease in Agriculture Productivity CBS Report 2011/12

Crop Name	% increase or decrease in cropping area in 10 Years
Paddy	Decrease by 6%
Wheat	Decrease by 6%
Maize	Decrease by 12%

The table [4] below shows import and export of High Value crops, cereals, Medicinal and Aromatic Plants and Dairy Products.

Table 2: Import and export of high value crops, cereals, MAPs and Dairy Products (2009/2010)

Products	Exports Million	Imports Million	(Surplus/Deficit)
Lentils	3745	230	3515
Tea	1195	35	1160
Cardamom	1172	57	1115
Fruit	486	4715	-4229
Ginger	456	46	410
Vegetables	26	2097	-2071
Coffee	24	14	10
Beans	11	1379	-1368
Sub-Total High Value Crops	7115	8573	-1458
Cereals	112	4195	-4083
MAPs	440	N/S	440
Dairy Products	N/S	861	-861

It is seen that there is a serious deficit of cereal crops looking at the import scenario of Nepal.

2.2 Agriculture Extension

Nepal has pluralistic agriculture extension services. In addition to Department of Agriculture and Department of Livestock, many NGOs offer education and training to farmers. There are only 11838 Agriculture Extension workers (Table 3) in Nepal who are serving 38, 31,000 households through 378 Agriculture Service Centers. Given this fact, there is an imperative need to strategically plan an effective agro information dissemination method which will facilitate the end user farmer groups. Nepal Agricultural Research Council (NARC) is an autonomous body which supplements Ministry of Agricultural Development (MoAD).

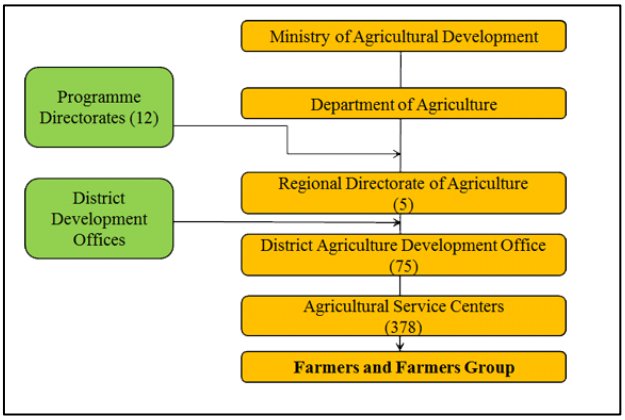

Figure 1: Agriculture Extension in Nepal

Further Information and Communication Technology have been significant in disseminating agriculture based information to farmers. Starting December 1966, 7 Radio Programs a week of each 15 minutes duration like "Sukrabar ko Budhi Aama", The Old Mother have been aired by Radio Nepal. Since 1996, 15 minutes daily program is being broadcasted by national Nepal Television which has been increased to 20 minutes since 2006. Agriculture Information and Communication Centre (AICC) has been publishing bi-monthly magazine for over 40 years which include agriculture diary, booklets, leaflets, calendars. Kantipur daily and other Newspapers have been covering Agro Information. Bi-monthly electronic journal 'Krishi' has been put for downloading in AICC website with various other booklets. The materials are in Nepali so that a literate farmer can read

Table 3: Number of Agriculture Extension Workers in Nepal

SN	Organization	Human Resource in Numbers		Total
		Technical	Non Technical	
1	Ministry of Agriculture and Development	57	75	132
2	Department of Agriculture	2848	2126	4974
3	Department of Livestock Services	2267	1793	4060
4	Department of food technology and quality control	179	52	231
5	Department of	3	591	594

	Cooperatives			
6	Other Central Level Organization	105	109	214
7	NARC			1765
	Total			11838

3. Objectives

The main objective of this research is to develop a strategic framework for knowledge transfer and skill development on Agriculture Information by implementing ICT in 4 VDCs of Gulmi. The objectives of the research are:

- To assess crop productivity scenario in Gulmi
- To measure the readiness of stakeholders primarily farmers, students, teachers in assessing importance of ICT in Gulmi
- To assess the importance of E-learning environment in educational institutions/farmer groups
- To propose design of delivery techniques of digital content in Agriculture Information Dissemination.
- To propose a ICT Model for appropriate Agriculture Information in selected areas of Gulmi

4. Methodology

- Identification of the VDC's for the research in Gulmi District. 4 VDC's (Baletaksar, Purtighat, Khadgakot and Thulolumpek) were identified for study purpose
- Meeting with the stakeholders for Agro Information Dissemination (NARC, AICC, MoAD, District Agriculture Development office (DADO) and Agriculture Information Centers in Gulmi District)
- Data Collection for the proposed VDC. At least 50 households in each VDC.
- Survey farmer's information need analysis using appropriate tools and technologies.
- Conduct analysis for selection of suitable ICT tools and technologies for information dissemination using Analytic Hierarchy Process and develop a strategic agriculture information dissemination method

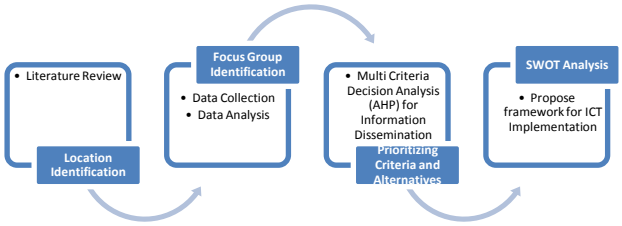

Figure 2: Methodology

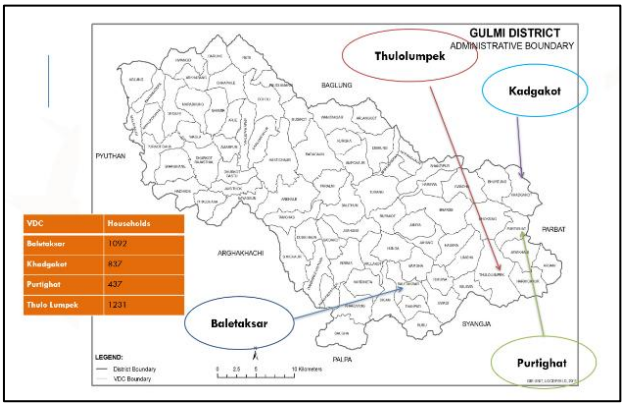

Figure 3: VDC Profile

The location identified for this project is 4 VDC's of Gulmi District Khadgakot Thulolumpek, Purtighat and Baletaksar. The total population of Gulmi District is 280,160. Futuristically, this research will usher project to maintain an Agro Repository which will have an outreach of 16191 people. The main interaction in the VDC's of the district will be through District Agriculture Development office (DADO), Gulmi. Senior Agriculture Development Officer (SADO) holds the overall responsibility of the DADO Gulmi. The sampling frame consisted of list of farmers from 4 VDCs of Gulmi District namely Baletaksar, Khadgakot, Purtighat and Thulo Lumpek. Primary Data required for the data analysis on decision making was obtained from both structured and unstructured questionnaire survey. Separate questionnaire was constructed, one for the farmers and other for the experts. The total number of households in those 4 VDCs is 3597 however due to limitation of time and resource a sample size of 196 households was obtained by proportionate stratified sampling because the population is divided into village development committees. In each locality, random sampling was done to pick the sample size which was proportionate to the VDC population. The advantage in stratified random sampling is to ensure inclusion. The sub-samples from the 4 VDCs were proportional to their sizes in the population which is calculated as follows:

Proportion = Total Sample Size/Total Households

=196/3597 = 0.05449

The calculated proportion was then multiplied by the VDC households to get the proportionate sample as shown in the table below. Similarly group discussions were carried out with experts who were directly or indirectly involved in the process of agriculture information dissemination. The experts were from District Agriculture Development Office (Gulmi), Agriculture Information and Communication Center (Lalitpur), Nepal Agriculture Research Council (Lalitpur), National Information and Technology Center (Kathmandu) and Directorate of Agriculture Extension (Lalitpur). Since the decision making on the suitable ICT alternative require analysis on various criteria, Analytic Hierarchy Process (AHP), a Multi Criteria Decision Analysis technique was used to select the appropriate alternative for Agriculture Information Dissemination. The level of importance of the criteria and priority of the alternatives as coded from the questionnaire survey of the experts will serve as input to AHP software Expert Choice Version 11.5.

5. Findings

The total number of Village Development Corporations (VDC) in Gulmi district are 79 with a population of 280,160.

Table 4: Number of Households in 4 VDCs

VDC	Households
Baletaksar	1092
Khadgakot	837
Purtighat	437
Thulo Lumpek	1231

There are four technical sections in DADO Gulmi which are Planning, Plant Protection, Agricultural Extension and Horticulture Development sections. Agriculture development program are run in all 79 VDCs of Gulmi, six agricultural service centers and in few of pocket areas at the grass root levels. The supervision and technical backstopping in the VDC level are done through 6 Agriculture Service Centers each for agriculture and in the district level are done through one head office, DADO. The research project identified pocket areas scattered in 4 VDCs identified. Furthermore the data of number of Students and Teachers in different levels is shown below.

Table 5: Financial Engagement of People in Gulmi District

Level	Students		Teachers	
	Male	Female	Male	Female
Primary	31964	33070	1421	594
Lower Secondary	11650	11602	498	60
Secondary	5215	5248	345	14
Higher Secondary	707	807	NA	NA
Total	49536	50727	2264	668

43.7% of the people were engaged in Agricultural occupation out of which 46.6% were females. The percentage of people with small farm holdings (less than 1 Ropani =508.72 square meters) were significantly high with 86.7%.

Table 6: Farm Size of the Farmers

Farm size (Ropani*) 1 Ropani=508.72 sq m	Frequency	Percentage
1 to 10	170	86.7
11 t0 20	22	11.2
20+ above	4	2

A descriptive analysis was done to describe the farming experience of the respondents in agriculture. The result indicated that 4.6% of farmers had less than 5 years of farming, 29.1% had done farming for 5-10 years while 66.3% had more than 10 years' experience in agriculture

Table 7: Education Level of Farmers

Item	Frequency	Percentage
No formal Education	6	3.1
Adult Literacy Education	26	13.3
Primary Education (Class 1 to5)	49	25
Secondary Education* (Class 6 to 10)	68	34.7
Post-Secondary Education** (Above 11)	47	24

The survey also showed that about 34.7% of the farmers had secondary education level. Furthermore, the analysis of the income levels of the farmers engaged in the study indicated that 39.3% of the farmers interviewed earned less than Nepalese Rupee 180,000 a year. Similarly 27% of the farmers earned between Nepalese Rupee 180,000-360,000 a year and 33.7% of the farmers earned above Nepalese Rupee 360,000 a year. An income of around 700,000 per year was observed in Baletaksar VDC. This might be due to the fact that the respondent who possessed more than 20 Ropanis of land were engaged in commercial

farming too. Similarly, the lowest income of around 84,000 was observed in Khadgakot VDC.

The surveyed VDCs were found to be covered by mobile phone network. The main network operators are Nepal Telecom and Ncell Private Limited. The analysis of the mobile phone indicated that 95.4% of the farmers possessed mobile. The analysis of the usage of internet by the farmers indicated that 23% of the farmers are internet users while 23% of farmers had offspring who were internet user. Similarly 4% of the farmers had siblings who use internet while 50% of the farmers did not use internet or have anyone who would use internet for information access. The table below presents the descriptive analysis of the internet usage by the farmers or the members of their households. The result also indicated that 50% of the household have an internet user.

Table 8: Frequency Distribution of the internet usage by the farmers

Internet User	Frequency	Percent
Self	45	23
Offspring	45	23
Siblings	8	4
None	98	50

The analysis of the association of the respondents to a farmers' group was done. The analysis indicated that 64.8% of the respondents were not associated with any farmers' group as such, while 35.2% indicated that they were associated to a farmers' group. The table below indicates the description of the frequency of famers' group association.

Table 9: Farmers' group association of the farmers

Farmers' Group Association	Frequency	Percent
Yes	69	35.2
No	127	64.8

An analysis of the availability of the ICT namely radio, television, mobile, internet and print media for access of agriculture information was done. The result indicated that radio is available to 82.1% of the respondents for access of agriculture information. Similarly, 67.3% of the respondents have access to agriculture information through television, while 95.4% of the farmers possess mobile for accessing agriculture information. Only 4.6% of the farmers have access to internet for accessing agriculture information. The figure below indicates the availability of information and communication technologies among the farmers.

Table 10: Information source of the farmers

Information Source	Frequency	Percent
Neighbors (farmers)	72	36.7
Farmers' Group / Co-operatives	16	8.2
Trainings/Seminars/ Workshops	39	19.9
Agriculture officers/JTA/ Agro-experts	56	28.6
Others*	13	6.6

(Others*: Newspaper, None taken, self-informed, personal contacts, input distributor, etc).

DADO Gulmi is a district level Government agency primarily mandated for planning, executing, coordinating and monitoring agricultural programs in the Gulmi district for the wellbeing of people in Gulmi. The study investigated the ICT tools used by District Agriculture Development Office, Gulmi for agriculture information dissemination. Apart from the usual traditional radio and television programs, usage of mobile for information access by farmers was reported by Senior Agriculture Officer of DADO, Gulmi. Lack of basic infrastructure such as road and telecom facilities are the main hindrances for disseminating agriculture information as stated by DADO, Gulmi.

There are altogether 6 agriculture service centers and 7 communication centers excluding the DADO office at Tamghas. The unreached population is facilitated by agriculture technicians (JTA) for information access. But the resources are inadequate in catering all the farmers of Gulmi. Realizing the importance of mobile in information access, DADO, Gulmi have launched a toll free number where farmers can connect to get agriculture information. The utility of the toll free number is satisfactory as reported by the officers at DADO, Gulmi. But the investigation of the same among the farmers found that they are unaware of the toll free number. Other initiatives taken by the DADO, Gulmi are mobile training and horticulture in school. Mobile training is a program where agriculture experts visit to villages where transportation is available. Horticulture in School is a yearly program where selected and interested students are trained on basic horticulture practices.

Given the socio-economic challenges and other criteria, this research also sought to establish the appropriate ICT that can be applied for information dissemination. The establishment of appropriate or effective ICT for information access was studied through the attitude of famers. The effectiveness of the ICT tools such as radio, television, mobile phone, internet and print media was measured in likert scale of

5 where 1 indicated not effective and 5 indicated very effective. Effectiveness of the various ICTs and results are discussed below.

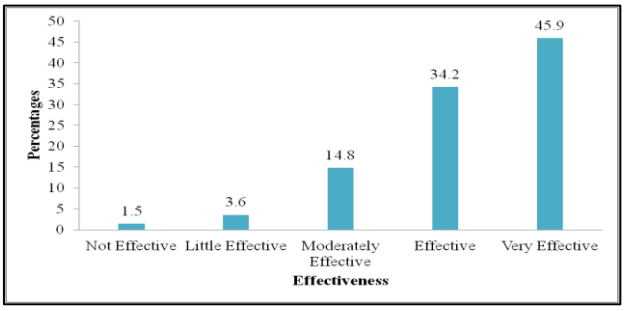

Figure 4: Effectiveness of Radio

The result also indicated that 42.9% of the respondents rated radio as little expensive, 29.6% rated it as not expensive, 21.9% rated it as moderately expensive, 3.6% rated it as expensive and 2% rated it at very expensive. The earlier findings indicated that majority of respondents possessed radio and majority rated it as little expensive or not expensive at all. The figure below represents the frequency description of the expensive rating of radio.

Daily agriculture news broadcasting in Nepal Television is a recent initiative and achievement of AICC. Agriculture television programs have been made more attractive with inclusion of teleserial, agriculture talk program and lesson from agriculture in foreign countries.

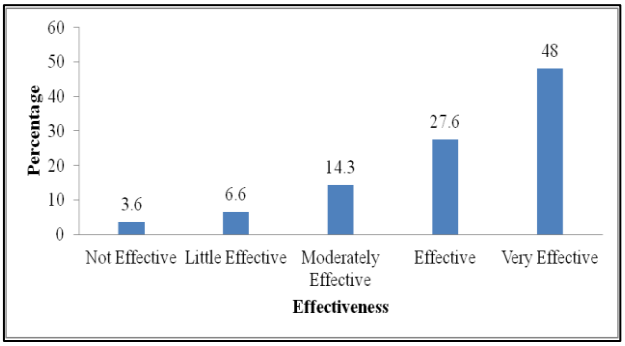

Figure 5: Effectiveness of Television

The findings also indicated that majority of the farmers rated television as expensive.

The results indicate that 33.7% of the respondents rated television as expensive, 31.1% rated it as very expensive, 8.7% rated it as moderately expensive, 25.5% rated as little expensive and 1% of the farmers rated it as not expensive. About 55.1% of the farmers deduced Mobile to be moderately expensive. Majority of the respondents 58.2% rated internet as very expensive. About 48.5% of the respondents said that the print media was little expensive.

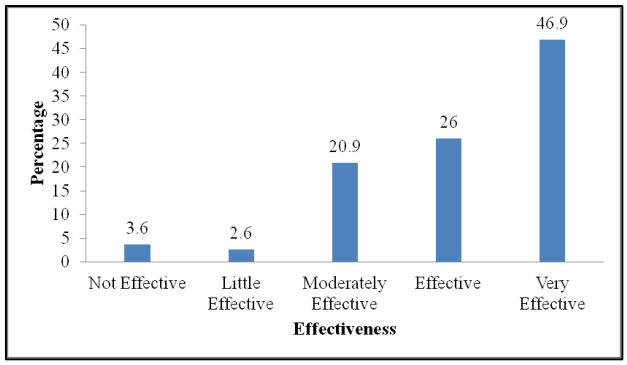

Figure 6: Effectiveness of Mobile Phones

Agriculture Productivity in Gulmi

It is seen from this statistics that Maize production tops other cereals or grain crops in terms of production and yield. The agriculture sector productivity is in surplus in the Western Hills and Gulmi where aggregate food production is positive.

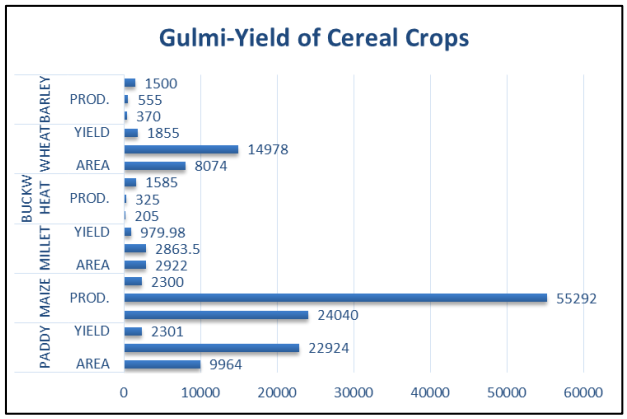

Figure 7: Production of Cereal Crops

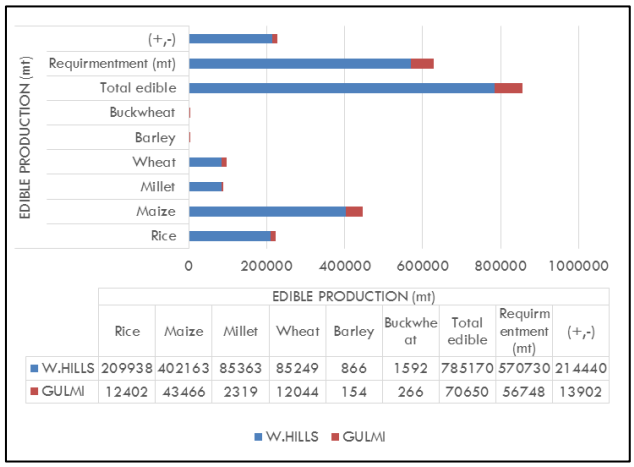

Figure 8: Edible Production of Cereal Crops

Maize is the maximum consumed cereal crop with 43466 mt/ha. Sugarcane on the other hand is the prime cash crop in Gulmi.

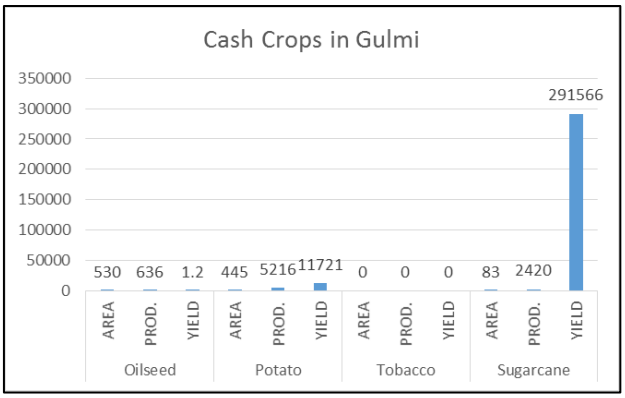

Figure 9: Production of Cash Crops

Similarly the production of Oil Seeds, Major Spice Crops, Pulses and Coffee is shown in the figures below.

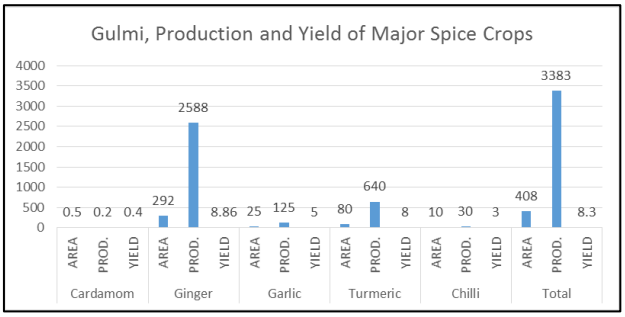

Figure 10: Production of Major Spice Crops

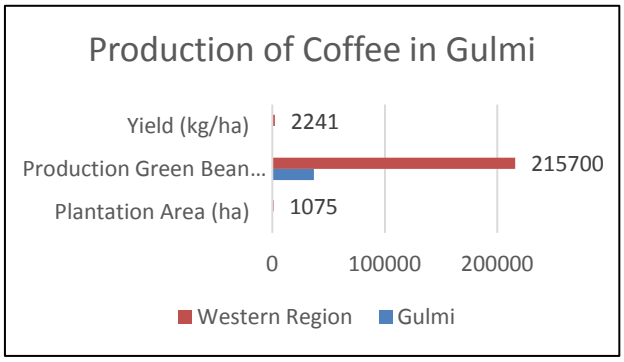

Figure 11: Production of Coffee

The study also sought to find out the agriculture products that are traded by the farmers. The general agricultural commodities of Gulmi district are rice, maize, millet, wheat, barley potato, and sugarcane and oil seeds. The table below indicates the agriculture commodities that are sold by the respondents.

Table 11: Agriculture commodities sold by the farmers

Agricultural Commodities	Freq (Yes)	Percent (Yes)	Freq (No)	Percent (No)
Rice	55	28.06	141	71.94
Maize	86	43.88	110	56.12
Millet	49	25.00	147	75.00
Wheat	35	17.86	161	82.14
Barley	5	2.55	191	97.45
Potato	60	30.61	136	69.39
Sugarcane	11	5.61	185	94.39
Oil Seeds	0	0.00	196	100.00
Others*	80	40.82	116	59.18

(Others*: vegetables and livestock and dairy products)

Similarly, the figure below represents the percentage of farmers selling the agriculture commodities. The figure indicates that highest number of the farmers sell maize.

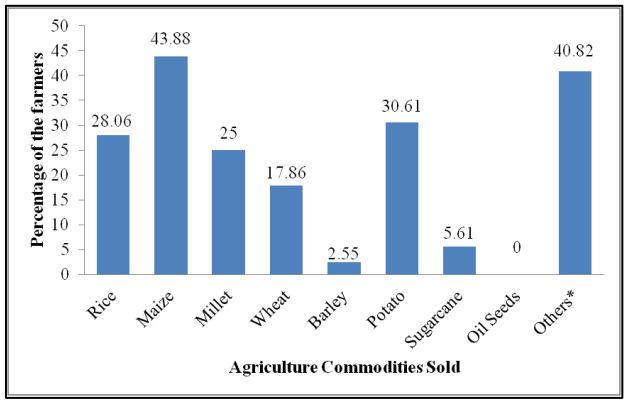

Figure 12: Percentage of farmers selling different agricultural commodities

(Others*: vegetables and livestock and dairy products)

Similarly the study also sought to find the agriculture commodities that are bought by the farmers. The table below indicates the same. Rice is the major commodity that is bought by the farmers.

Table 12: Agriculture commodities bought by the farmers

Agricultural Commodities	Freq (Yes)	Percent (Yes)	Freq (No)	Percent (No)
Rice	112	57.14	84	42.86
Maize	11	5.61	185	94.39
Millet	12	6.12	184	93.88
Wheat	5	2.55	191	97.45
Barley	1	0.51	195	99.49
Potato	42	21.43	154	78.57
Sugarcane	1	0.51	195	99.49
Oil Seeds	49	25.00	147	75.00
Others	24	12.24	172	87.76

(Others*: vegetables and livestock and dairy products)

About 57.14% percent or the majority of the respondents buy rice whereas 43.88% people sell maize.

6. Strategic Planning for Agriculture Information Dissemination

6.1 Information Need

The study also sought to find the solutions which would sustain the information system and support for unforeseen situations. The ownership of the system is the major criteria for sustainable information system. Hence the study also aimed at finding what the best mode of ownership for sustained agriculture information system. The figure below indicates that responses of the farmers on the ownership of the information system. The results indicate that 109 out of 196 farmers believe that the system will be sustained if the owner is taken by the government while 76 farmers believe the ownership must be taken by farmers' group. 11 of the respondents believe the ownership must be taken by a private organization for sustained information system

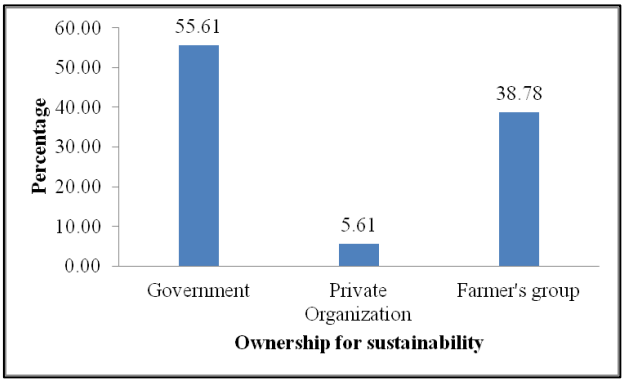

Figure 13: System ownership Opinion of the Farmers

The table below indicates the type of information need of the farmers. Majority of the farmers reported that need for general information as discussed in the model while others replied information on geo-specific crops, new variety crops, etc. The figure below represents the information need of the farmers. The general needs were information on diseases, nutrition management, farm management, new crops, input availability, market information, weather information, irrigation, finance and storage.

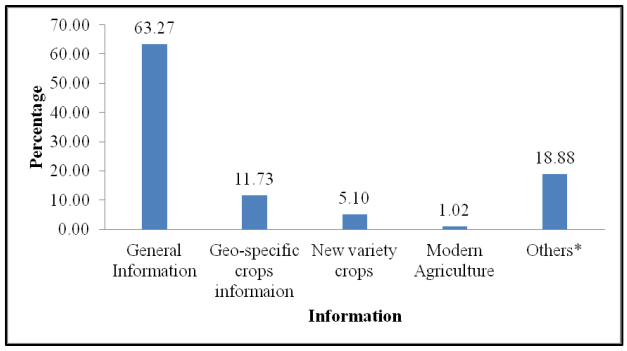

Figure 14: Information Need of Farmers

General Information*: disease and pest management, weather information, etc

Others*: training, market management, productivity

6.2 Analytic Hierarchy Process

In this research, comparisons of criteria and sub-criteria are made from the standpoint of expert views. To conduct the comparisons properly, 9 Experts from Agriculture, Forestry, Information and Technology were approached. The pairwise comparisons were computed through Expert Choice Software. Since the inconsistencies has to be <0.1, first the inconsistency of criteria wise decision matrix was checked. The following tables show the weights of the criteria and subcriteria.

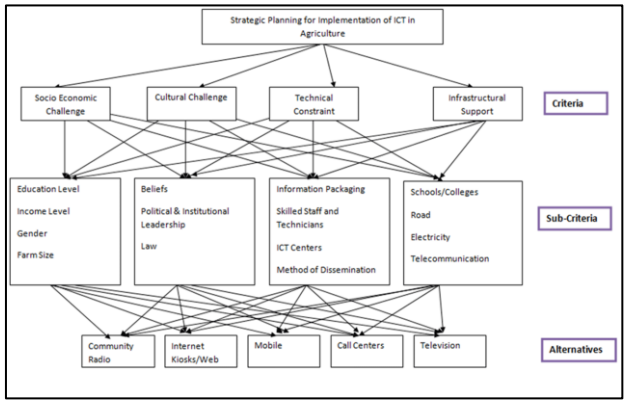

Figure 15: AHP Model of Strategic Planning of Implementation of ICT in Agriculture

The dichotomous questions from the Analytic Hierarchy Process [6] were analyzed using software package – "the Expert Choice Version 11" was used to process the resulting data. The Eigen values, consistency indices and consistency ratios obtained from the processing of the information supplied by the respondents revealed that the consistency indices (CI) were less than 0.1, indicating consistency in judgmental values of the respondents. A four criteria (Socio Economic Challenges, Cultural Challenges, Technical Challenges, Infrastructural Support and

fifteen subcriteria model was modelled and expert ratings were quantized using Analytic Hierarchy Process (AHP).

Five alternatives, Community Radio, Internet, Mobile, Call Centers and Television were placed as alternatives and the prioritized alternatives were construed from AHP Method.

Table 13: Weights of Sub Criteria

Criteria	Subcriteria	Local Weight	Global Weight
Socio Economic Challenges (L: .225 G: .225)	Education Level	.538	.121
	Income Level	.138	.031
	Gender	.066	.015
	Farm Size	.138	.031
Cultural Challenges (L: .080 G: .080)	Beliefs	.201	.016
	Political and Institutional Leadership	.445	.035
	Law	.354	.028
Technical Challenges (L: .271 G: .271)	Information packaging	.127	.034
	Skilled Staffs and technicians	.374	.101
	ICT Centers	.259	.070
	Method of Dissemination	.241	.065
Infrastructural Support (L: .425 G: .425)	Road	.177	.50
	Electricity	.138	.059
	Telecommunication Support	.099	.042
	Schools/Colleges	.646	.274

The Normalized rankings of the alternatives showed that Community Radio was the prioritized mode of information dissemination.

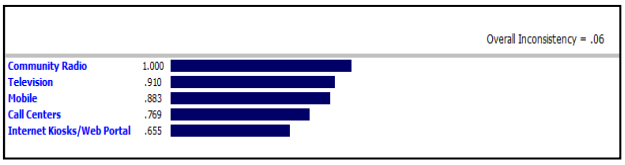

Figure 16: Normalized Ranking of Alternatives

6.3 SWOT Analysis

According to the Ministry of Local Development's Minimum Conditions and Performance Measures (MCPM) assessment, Gulmi was the 4th-best-performing district in Nepal in 2010/2011. There are well equipped District Agriculture Development Office at Gulmi with 4 technical sections (Planning, Plant Protection, Agricultural Extension and Horticulture). DADO Gulmi has 6 Agriculture Service Centers (ASC) and a total of 47 employees and running agriculture development programs in all 79 VDCs which are major strengths. Almost 87 percent of the farmers have farm size of less than 10 ropanis. This indicates that most of the farmers of Gulmi are engaged in subsistence farming rather commercial. Around 65 percent of the farmers reported that they were not associated with any farmers' group. There are all together 5 FM stations including Radio Nepal's FM relay station that broadcast agriculture information the evident lack of digital agriculture content impedes the growth in knowledge of farmers. The opportunities could be improving market access, augmenting agricultural production while the threats are changing socio-economic characteristics of the farmers because the targeted population (farmers) is viable to change their income generating activities. Lack of Policy interventions in ICT due to political and institutional leadership and Farmers' perception of ICT could also act as threat.

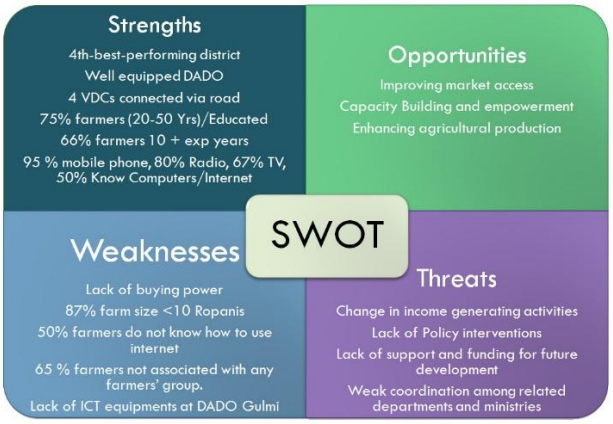

Figure 17: SWOT Analysis

6.4 Backbone ICT Infrastructure

A 5.8 GHz microwave link between Pokhara and Tamghas, the district headquarters of Gulmi has been established by E- Networking Research & Development (ENRD), Nepal. ENRD has already setup 24km wireless link between Pokhara, Kaski and Mohore, Myagdi which is at an altitude of 3200m.There is a 41 km P2P link between Mohore and Satyabadi. A 2.4 GHz Microwave link for network distribution in schools and Villages has been used. This is the support wireless infrastructure for local wireless distribution in the target VDC's. This infrastructure which is already set up in the target district is another motivation to create a digital agro information system.

There are E-Libraries already established in the schools in Gulmi (Nepal Rastriya Secondary School, Deurali Secondary School, Shahid Smarak Secondary School

and Kalinaag Secondary School). There are also Computers in the Cooperatives of the villages. There is also supporting wireless infrastructure between Pokhara and Tamghas and the target villages in Gulmi through MicroWave link.

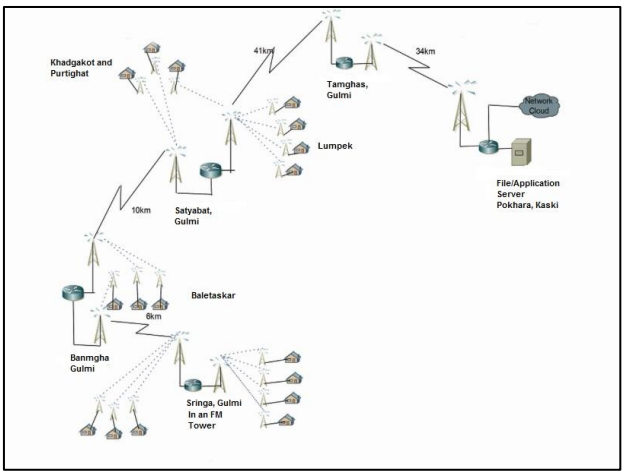

Figure 18: ICT Backbone Infrastructure in Gulmi

7. Case Studies

Throughout this research several cases were studied few successful one are mentioned below:

Reuters Market Light: Provisions customized commodity pricing information, local news and weather updates. RML provides information relevant to 54 commodities in 270 crop wholesale markets (mandis).

eChoupal 3.0: is the newest version which is destined to be released in 2012. The new version is planned to integrate mobile devices into the eChoupal's management information system. eChoupal is a success story which allows farmers to get up-to-date knowledge of market prices for their commodities. eChoupal 3.0 plans to offer personalized crop management advisory services to individual farmers.

Digital Green: Farmer participatory video for agricultural extension. 1681 videos produced and 60313 farmers involved. Increased seven fold more adoption of farm practices and ten times more effective per dollar spent as compared to traditional extension system (www.digitalgreen.org)

Upveda's own initiative has also been significant in furthering ICT led innovation in agriculture sector. The 'Agro Portal' www.ndri.org/agroportal is an initiative undertaken by Nepal Development Research Institute (NDRI) in collaboration with Nepal Agriculture Research Association (NARC) and Department of Hydro and Meteorology (DHM) to transfer appropriate knowledge and technologies to the farmers helping them to sustain their farming activities in response to the climate change.

Agro-portal is a hub, specially designed to bring all the information related to agriculture together in one place from diverse sources. It provides easy access to the useful information for the agricultural activities in Nepal including types of seeds, fertilizers, pesticides and its use and availability in nearby locality, method of pesticides control and management practices in major crops of Nepal based on seasonal cropping calendar. The main target domain of this portal is the frontline farmers, line agencies including Ministry of Agricultural Development (MOAD), Department of Agriculture (DOA), District Development Office (DDO), Agricultural and sub-agricultural centers, Veterinary Service Center, NGOs, Universities, market stakeholders, Cooperatives, Farmer groups, etc.

8. Conclusion and Recommendations

Information and communication technologies have become popular and effective in India and neighboring countries for agriculture information dissemination. The research indicated that farmers' information needs can be addressed by the combination of push pull technologies such as mobile phones, radio, television and internet. Keeping in mind the availability of the ICT equipment present at farmer's premise, information need of the farmers and decision making criteria for ICT implementation, the following multimodal ICT dissemination system has been recommended. There is requirement for an integrated approach which would address information needs in using ICT applications. The Government of Nepal has identified Technology is one of the main components of 20-year Agriculture Perspective Plan (APP) as well as NARC Vision 2021.

Utilization of community radio as experts ranked it of highly suitable alternative followed by television, mobile phone, call centers and web portals. Literature suggest push and pull mechanism hence a query processing unit where farmers can get solutions to their questions is recommended. Majority of the farmers sell maize, vegetables and potato hence the content of the information is recommended within these domains. Finally a centralized web based backend integrated with mobile and interactive voice response system (IVRS) at frontend is recommended along with establishment of ICT center at school/colleges specifically for agro-information is recommended.

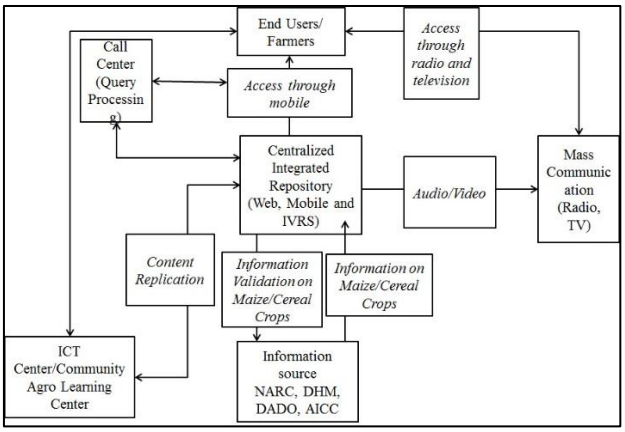

Figure 19: Agriculture Information Dissemination Model

The framework could be implemented and maintained under the supervision of government agricultural bodies, such as the Department of Agricultural Extension or the Ministry of Agriculture, or run by academic institutes, such as agricultural colleges or departments of agriculture in universities, which are sources of accurate and credible agricultural information. This framework is a composite system for delivering on time farm information to farmers through push and pull technology. It uses a combination of the Internet, basic phones, smart phones and IVRS for disseminating information, and has a centralized database containing multimodal content. The major features of the system are:

Web, mobile and IVRS based system

The findings indicate that 50 percent of the households have member who can use internet. Similarly 95.4 percent of the farmers possess mobile and are more comfortable with audio and video information rather text. Hence the proposed strategic framework will be composed of an integrated system of web application, mobile (voice) and interactive voice response (IVR) system.

Multimodal content format (audio, video and text)

This research sought to find the mode of information that is comfortable with the farmers. The findings indicate video format is preferred more than video followed by text mode.

Multilingual

The proposed framework will have the features of accessing information in Nepali, local language and English language. The findings indicate that farmers have preferred Nepali language over local language followed by English.

Multi-platform: web based backend and a mobile interface and IVRS for the frontend

The strategic framework for ICT implementation in agriculture information will have a central component based on web backend and will be integrated with mobile and IVRS at the frontend. The central system also consists of call center as the experts have prioritized call centers as one of the suitable alternatives for information dissemination. Call center will be responsible for addressing farmer's queries and the queries will be recorded in the central system for future analysis.

Content (Cereal Crops)

The findings indicate that most of the farmers are engaged in agriculture domain with few in horticulture and animal husbandry. Hence this framework will primarily focus on the agriculture domain. The findings indicate that out the common agriculture commodities (Rice, maize, millet, barley, wheat, potato and oil seeds), maize is sold by almost 44 percent of the farmers followed by others* (vegetables, livestock and dairy products) and potato. Hence the content of the information will focus mainly on cereal crops with maize as the major source of income generating cereal crop.

ICT Center for agro learning management

The findings indicate that lack of ICT center is a major issue for information access through ICT media. The findings also indicate the ICT centers have been prioritized by farmers as one of the important subcriteria of technical challenges to be considered for agriculture information access. Hence ICT center is also considered as a major component in the proposed framework. The ICT center located at the research areas will serve as training and learning platform for agriculture domain especially of maize. With the introduction of ICT center, the capacity building of the farmers or the users is anticipated. The ICT center will offer an on time multimodal solutions to Gulmi farmers irrespective of functional literacy, language and other socio-economic conditions.

This research attempted to build a system that offers an on time multimodal solution to Gulmi farmers irrespective of their geographical location, functional literacy and language. Increasingly, ICT initiatives are required to prove their effectiveness through more sophisticated, technology driven methods. This paper seeks to introduce the Strategic framework as an inexpensive, fast and robust information dissemination system for farmers and farming organizations operating in Gulmi. The strategic framework would be able to deliver benefits to farmers more effectively in both

online and offline modes vis-à-vis a traditional web or mobile based application.

The figure below shows an elaborate 'Centralized Integrated Repository'. The 'Centralized Integrated Repository' will contain

1. Master Data Management System
2. Information Dissemination System
3. End User Engagement System

The Central Depository system will contain all the necessary information regarding Crop Rotation. A much Personalized Advisory can be proposed/deployed based on individual farmer/community needs. A minimal charge for using the service can be debited from customer's user balance. The personalized Interactive Voice Response (IVR) based system can also be installed where the customers could be given free service for a specific number of IVR calls after which the customer could be charged. This could also be proposed for Unstructured Supplementary Service Data (USSD) based services.

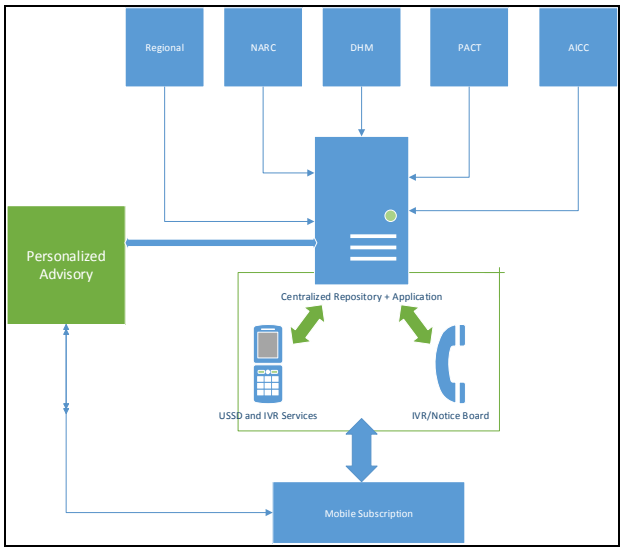

Figure 20: Revenue Generation Model

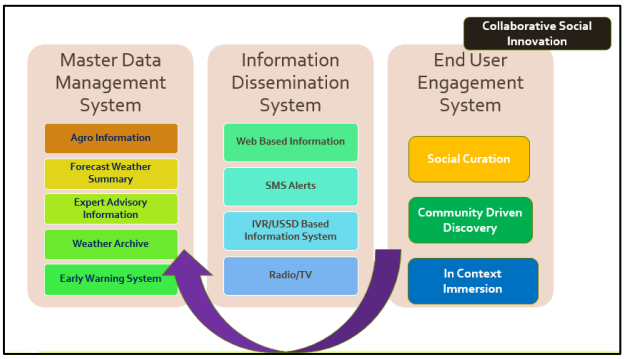

Figure 21: Centralized Agriculture Information Repository

The 'Centralized Integrated Repository' will act as the System Core. An android application can be developed alongside the repository. A proposed technical model shows that the 'Central Repository' will act as the core of the Android System as well where through Web Services, the content could be made available to any android devices. This could be used by farmer community or NGO's/INGOs/Government agencies working with the community.

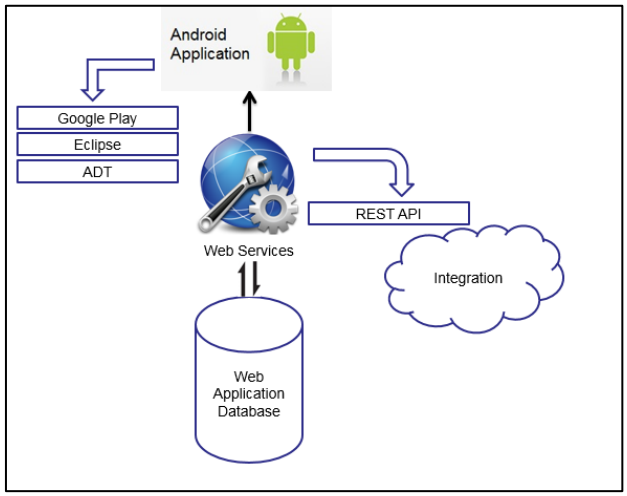

Figure 22: Android Application Framework

Sustainability

The sustainability could be broadly grouped in to three cases:

- A successful business model, where the service costs are covered by revenue: user payment, 3rd party fees for advertisements, data, etc. (private sector).
- A successful service model, where the service is taken on as part of the mandate of a government office (public sector).
- An innovation/technology being taken on by the target and continuing after the project.

The innovation, knowledge of the farmers could be utilized in order to create 'Accommodating Innovation and Knowledge sharing based on farmers' experience.

Collaborative Social Innovation

While roles are not always agreed upon, the importance of public-private partnership is imperative. Partnerships and collaborative social cohesion between advisory service providers and Multi National Organizations could potentially offer subscriptions to extremely affordable voice and data services at scale to farmers. Telecom service providers and telecom regulating authorities like Nepal Telecommunication Authority could play a primary role in strengthening

this cohesion by accelerating the growth of the innovative ICT ecosystem.

Content

If ICT are to provide real decision tools, it will be necessary for an "ecosystem" of relevant information and data to exist. This sort of information is under development in some examples, but in many cases there is lack of clarity regarding who should be responsible for the creation or mobilization, quality assurance and dissemination. Information should be developed according to need of the end users (e.g. farmers), and provided in local languages, in simple, interactive form. It must be up-to-date, relevant and supplied in a timely manner. Some felt it would be essential to offer a continuum of information required for successful farming, not simply to focus on one piece of relevant data.

Recognizing Indigenous Knowledge

There is a need to harness indigenous knowledge for the development of extension service. A country's knowledge base needs to be developed and fostered to both improve its competitive position and to contribute to human and sustainable development goals [7]. This is evident when local, scientific and technical information are properly managed and used. Special emphasis could be placed on developing and disseminating local content, improving the relevance of the information to local development, as well as capturing and auditing all relevant local resources.

Acknowledgements

Authors are thankful to Centre for Applied Research and Development (CARD), Institute of Engineering without whose support this research could not have been completed. The authors also thank Masters' Program at the Institute of Engineering, Tribhuvan University in Technology and Innovation Management (TIM) since 2010 with the support of the Norwegian University of Science and Technology (NTNU), Trondheim, Norway through NOMA Funding for entrusting the authors to develop a concept and materialize it.

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