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ON IMPROVEMENTS OF AGRICULTURAL EXTENSION SERVICES FOR CONTRACT FARMING

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ВДОСКОНАЛЕННЯ АГРАРНИХ КОНСУЛЬТАЦІЙНИХ ПОСЛУГ ДЛЯ КОНТРАКТНОГО ФЕРМЕРСТВА

The goal of this research was to facilitate further development of contract farming in the Maldives which encounters with serious obstacles caused by islands remoteness and outdated agricultural techniques. Assessment on education, awareness and challenges faced by Maldivian small holder farmer communities was done through a qualitative study based on the interviews of AgroNAT registered farmers. Their prevalent majority was presented by male farmers above 40 as well as female farmers under 40. Respondents revealed that they failed to get timely support and guidance from agricultural extension offices due to time and logistical constraints. The research calculations recommended that visiting rural farmers' communities should be arranged between the dispersed islands following the quickest one-cycle routes found via the proposed optimization model. According to the fulfilled chi-square tests for independence, contract farmers demonstrate sufficient level of digital skills so that mobile technology can provide effective delivery of contemporary agricultural knowledge among male and female farmers aged above and under 40. The research outcomes presented the major topics of sending regular text messages including information on how to monitor cultivation and harvesting, apply

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fertilizers and chemicals, get access to low-cost inputs, possible market avenues, logistic options and pricing, updated weather forecasts, and also methods of crisis management to avoid natural risks. Moreover, through credit-based systems farmers could be provided with smart phones which they can use to connect with the extension officers to address their concerns. In addition, we advise that AgroNAT as the main state contract farming company organized online consulting services through its official website and links to information and videos in the native language. Farm monitoring app is another tool that farmers can utilize via their smart phones. This application will further increase their production and enhance the produce quality as it will act as means to support and guide the farmers' activities from sowing to the harvesting point.

Метою даного дослідження було полегшення подальшого розвитку контрактного фермерства на Мальдівах, що стикається з серйозними перешкодами через віддаленість островів та застарілі сільськогосподарські технології. Проведена оцінка освіти, обізнаності та викликів, що постають перед громадами дрібних фермерів на Мальдівах, здійснювалася на підставі опитування фермерів, зареєстрованих у компанії AgroNAT. Їх переважну більшість становили чоловіки фермери старші 40 років та фермери жінки до 40 років. Респонденти відзначили, що вони не одержують вчасної підтримки і керівництва від аграрних консультантів унаслідок часових та логістичних обмежень. На основі обчислень дослідження рекомендовано відвідувати сільські громади фермерів на віддалених островах, дотримуючись найшвидшого одноциклового маршруту, що був знайдений у запропонованій моделі оптимізації. Згідно виконаних Хі-квадрат тестів на незалежність, контрактні фермери показують достатній рівень цифрових навичок, завдяки чому мобільні технології можуть забезпечити ефективне поширення сучасних сільськогосподарських знань серед фермерів чоловіків та жінок віком до та понад 40 років. Результати дослідження презентували головні теми надсилання регулярних текстових меседжів, включаючи інформацію про моніторинг вирощування та збирання врожаю, внесення добрив, доступ до дешевих ресурсів, ринків, логістичні опції, ціноутворення, оновлені прогнози погоди, методи кризового менеджменту для запобігання природних ризиків. Крім цього, через системи кредитування фермери мають бути забезпечені смартфонами для зв'язку з консультантами з приводу вирішених проблем. Рекомендовано, щоб AgroNAT, як головна державна компанія для контрактного фермерства, організувала онлайнові консультаційні сервіси на офіційному вебсайті та через лінки до інформації та відео на рідній мові. Комп'ютерна програма моніторингу ферми є іншим засобом, що фермери зможуть використовувати на власних смартфонах. У такий спосіб відбуватиметься подальше підвищення обсягу та якості продукції, адже цей засіб підтримуватиме і керуватиме діяльністю фермерів від сівби до збирання врожаю.

Key words: contract farming in the Maldives, agricultural extension services, model of optimal route, gender and age profiles, mobile communications.

Ключові слова: контрактне фермерство на Мальдівах, аграрні консультаційні сервіси, модель оптимального маршруту, профілі статі та віку, мобільні комунікації.

STATEMENT OF THE PROBLEM IN A GENERAL FORM AND ITS CONNECTION WITH IMPORTANT SCIENTIFIC OR PRACTICAL TASKS

Education and Information Technology plays a huge role in empowering the rural farming communities to gain knowledge and skills in enhancing productivity of the farmers. Small holder farming communities require continuous access to information on improving crop yield, ways of tackling plant and pest diseases. They need to be aware of the latest farming technologies and require adapting these technologies to meet the consumer needs and gain competitiveness.

According to the Ministry of Fisheries and Agriculture, 8000 registered farmers contribute less than 5% to the national GDP [6; 7]. Farming has been and is prominent in the livelihoods of the rural population of the Maldives. The agricultural small and medium sized enterprises play an important role in food and nutrition security, especially for those who are residing in the rural areas, creating job opportunities, boosting economic growth, and maintaining a stable social environment [4].

A small study on the agricultural extension officers in the Maldives shows that, the training carried by the World Bank, UNDP, and IFAD does not meet the training needs of developing the

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advisory officers as it skips agricultural entrepreneurship improvements, sustainable farming methods and management skills. This study also revealed that only 20% of the extension officers believe that they have a key role in facilitating collaboration and coordination in farming [5].

This clearly reflects the huge gap that exists in equipping farming communities of the Maldives which practice outdated conventional agricultural method. In particular, excessive use of fertilizers and chemicals is a common drawback observed among the local farmers. Geographical remoteness, unavailability of extension officers, guidance and training hinder these farming communities to benefit from their agricultural activities. Most farmers have no access to market information. Their produce is being bought by the suppliers for a lower price and sold off in market for a higher price. Farmers are at the end of loss where they gain no benefit from other than daily food and nutrient requirement. Lack of knowledge, skills, and technology prevents these farmers from producing quality produce that is demanded by big chain of restaurants and resorts forcing them to import locally grown fruits and vegetables at a higher price [6; 7].

Contract farming is an agreement between the farmer and the company to produce agricultural production for a pre-agreed price [7; 11]. The company provides the farmers with necessary inputs and an effective technology to meet some requirements on the quantity and quality produce. This binding agreement includes a whole range of stakeholders such as farmers, suppliers, buyers, and different markets. The contract farming model that is implemented in the Maldives, would best benefit if there is well balanced coordination and collaboration between the stakeholders of the chain.

Family farms comprises the large part of the agricultural system in both developed and developing countries and hence it has become the main producers of food consumed there. Agricultural extension services (AES) play a huge role in bringing the latest new technologies and market information to the small holder farming communities. However, over the years it has been observed that the AES lack the capacity in delivering the required knowledge and expert opinions to the farming communities due to many reasons such as time, money and other logistical difficulty that prevents them from outreaching the farming communities [9; 13].

Unfortunately, it is complicated owing to long distances and time constraint which manifest themselves through the lost opportunities for the rural family farming communities to enhance their capacity of production, ensuring guaranteed source of income and market access. Thus, the major objective of our study is to understand the transmission of knowledge and skills, collaboration, and coordination among the contracted farmers in the Maldives and clarify recommendations to face the raised issue.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Contract farming model that is implemented by the AgroNAT company in the Maldives [3] helped many farmers including the contract and non-contract farmers in accessing farming information on cropping applying fertilizers, chemicals, and introducing technology-based farming method to improve production. Studies show that contract farming itself is a means to enhance the productivity and profitability of the farming communities. A research study carried on the broiler farmers of Lebanon showed that the contract broiler farmers are far better than the non-contract broiler farmers. This is because when the broiler farmers join the contract farming program, they are more guided in accessing quality inputs and supported with extension service to achieve economic benefits and scaling up their business [10].

The basis of the contract farming is to help the farmers in areas where they need support in producing higher quality yield and earning an income to provide the well-being of their life in a sustainable manner. To achieve this, contract farming arrangements are designed in such a way that promises benefits to both the producer and the contractor, known as different types of contract farming (CF) business models [17].

In particular, centralized contract farming business model is the most common type of CF where the buyers are strictly controlled and monitored from sowing to the harvesting point which guarantees a fixed quantity and quality of produce. A similar strictly vertically organized CF models was implemented by the Cottco-Cotton company in Zimbabwe. It established a contractual agreement with 77000 smallholder farmers and provided them with seeds, fertilizer, chemicals, technical advice, extension services and close monitoring from the point of sowing to the point of harvest [5]. This CF model empowered the farmers to work and grow higher quality produce as the amount of inputs they receive on credit is based on how well they perform in each harvesting cycle. This business model was further streng-

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thened by the Cottco-Cotton company by agreed incentives for the highest quality cotton by offering supplementary payment and cash bonuses. This prevented side selling as well as enhanced yield and production quality benefiting both parties.

Variation to the centralized model is the nucleus model where the buyer controls a centralized production and processing through owning the land of the farmers. In return farmers act as means of labor for the cost of technical assistance, extension service, inputs, and close monitoring and supervision [17]. Like centralized model, the nucleus one has a strict control and regulation over the production. Indonesian palm oil boom is the result of the nucleus contract farming model that was initiated by the Indonesian government. Indonesian state, along with the support of the World Bank spurred the economic development of rural oil palm farmers by establishing state owned oil palm plantations where farmers were given land and technical assistance in cultivating perennial crops. Later the government handed over it to the private companies by giving them land areas and subsided loans in exchange for recruiting smallholder farmers into their plantation plan. With these private companies, farmers got support and guidance in cultivating and increased their plantation efficiency via higher yields and incomes [8].

Multipartite contract farming model is based on the involvement of different parties in providing technical assistance, inputs, and management of agricultural function where there is a strict product specification [17]. The Kampot pepper production CF model is a multpartied CF implemented among the farmers in Cambodia. In this model farmers sign contracts with both cooperatives and private companies to distribute pepper both locally and internationally [15]. Kampot farmers are trained on a continuous manner to equip them with skills and knowledge, where their farming methods, techniques are strictly monitored and regulated based on specifications of the required product. In return farmers are guaranteed a higher price for their produce and access to new export market. It showed the Kampot farmers earned higher income than the non-Kampot, increasing their average annual income from $400 per a household in 2009 to $1750 per a household in 2015 [15].

Intermediary CF model is also a common CF model where company forms contractual agreements with the farmers through intermediaries such as lead farmers, farmer groups or buying agents [17]. Unlike the two models discussed above, an intermediary CF model has limited product specification. The snap-frozen vegetable industry in Northern Thailand, contracts with collectors who coordinates more than 30000 farmers who grow different varieties of beans. The company provide technical expertise, extension services through these collectors to the subcontracted farmers. This model provides access to the market through a middleman with the required support and services. It guaranteed a turnover to their produce. However, the lack of direct link between the company and farmer, lead to poor quality standards and irregular production [5]. The last and the least common type of contract farming model is the informal model. This is an uncommon method where the entrepreneurs or small companies form a very informal contract with the farmers on a seasonal production basis where the crops require minimal processing. In this model minimal inputs such as seeds and fertilizers are provided to the farmers [5].

All the above discussed models support farmers with advice about producing desired amount and quality of products by giving them access to knowledge, skills and technologies. The success of all these models depends on how well the partner company/buyer interacts with the farmers and how well they are fostered to meet the desired end goal. With this regard, many researchers in the field of developing agricultural sector has emphasized adopting Information Communication Technology (ICT) as a means of addressing the shortcoming of AES. ICT is a mode of telecommunication and computing technologies that helps in collecting contemporary information, knowledge and skills and acts a medium of dissemination of this information which includes mobiles, computers, and tablets [10]. Aligning this ICT medias along with the agricultural holders is a possible solution in bringing spur in economic development and growth as it gives accessA to information and technical support to all the farmers when it is required. In other words, it connects the farmers, agricultural business platforms, market, input suppliers, researchers, and government ministries at large [10].

In India mobile phones are used as a platform in bringing information to the rural farming communities through text messages. Over 200000 smallholder subscribers from 10 different states in India used as a means of accessing prices, commodities, and advisory services. Through this data base farmers were able to access information on 150 crops and outreach more than 1000 markets for a cost of US$1.5 per month. This cost-effective

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ICT strategy generated US$2-3 billion in income for farmers, while over 50% of them have reduced their spending on agriculture inputs [14].

Turkey agricultural department utilized ICT as a means of monitoring pest control and frost prevention which led to reducing pesticides by 50%. It also lowered expenses and improved crop productivity [12].

Indian agricultural companies have invested on integrating ICT to enhance the productivity of their farmers and have succeeded in achieving their targets. One such example is in the Indian Kisan Call Centre where farmers queries are effectively, efficiently, and instantly provided in the farmer desired local language. This project showed a huge improvement in the choices farmers made in selecting seeds, harvesting, farm management, agricultural economics, and plant breeding issues. Even today this call center is operating successfully along with 50 states and provides short-term productivity and crisis management information, as well as information for longer-term activities through weekly conference calls with topical experts [12].

One of the great advantages of using ICT in empowering the smallholder farming communities is that it is gender neutral [16]. Women who are greatly disadvantaged in the sphere of economic activities can benefit from ICT integrated agricultural approaches equally as men. According to Swaminathan M., women farmers who engaged in raising livestock have benefited greatly by voice messages that were shared through the mobile phones based on their requirements. Information on market access, innovative agricultural practices and input supply can be accessed and used by anyone who needs it but has limited access to such facilities due to gender specific issues observed in different communities [14].

As discussed above ICT is an efficient tool to scale up the small holder farming communities. However, there are many challenges that hinders the successful integration of ICT based AES within rural farming communities. A study carried to understand the challenges faced by the farming communities in Kenya and Uganda clarified that these farmers are in consistent demand for information on crop pest and disease diagnosis and management, fertilizer application, pesticide use and market information, weather advisories and livestock production [9]. AES programs were aired via radio and TV to which majority of the famers have no access. Though ICT is a gender-neutral tool, being able to access digital services is biased towards men compared to women in the examined rural areas. A huge challenge faced by these communities is lack of digital literacy and in accessibility to devices such as radio, TV, and smart phones. This study clearly reflected the huge gap that must be addressed in planning, organizing, and implementing ICT based AES system to support small holder farming communities [9]. Similar challenges are relevant to the contract farming in the Maldives [1; 2] and need to be examined as soon as possible.

RESEARCH AIMS

The research goals were to clarify means to improve agricultural extension services provided for contract farmers and specify directions of consulting depending on gender and age profiles of the family farming communities in the Maldives.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

The qualitative bases of the conducted research were groups of the primary stakeholders. The selected sample included 459 participants who were AgroNAT registered farmers and other farmers who operate independently. The interviews were carried out during field visits of AgroNAT for the purpose of recruiting farmers and understanding the challenges which decrease agricultural productivity. 9 focus group aggregated mostly female farmers. Almost all the farmers were above 35 years of age and had more than 3 years of farming experience. The key topics covered in discussions included trainings, skills, and knowledge; access to agricultural tools and equipment; affordability of fertilizers and chemicals as well as how to apply them properly; availability of extension officers; market information and logistics; maintaining the quality of farmers' produce; effects of farming on the livelihood; core challenges that farmers face in cultivation and harvesting.

It turned out that 362 farmers solely depend on farming as a means of income, only 67 interviewees use technology integrated farming, 87 farmers participated in farm management training, 189 respondents were familiar with innovative pest management, and 276 farmers were directly trained in agriculture.

All the farmers who participated in the focus group discussion, raised their concerns over not getting sufficient help and support from AES. Farmers agreed that they do receive information at least twice or once a year through training programs conducted by AES officers. These trainings mostly were focused on application of

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Table 1. Time (in minutes) taken to move between islands in the Maldives

From / To	#1	#2	#3	#4	#5	#6	#7	#8
#1	0	30	40	50	360	225	235	235
#2	30	0	10	15	360	120	125	130
#3	40	10	0	20	255	120	125	130
#4	270	15	20	0	360	225	230	235
#5	360	255	255	360	0	225	230	235
#6	225	120	120	225	225	0	10	100
#7	235	125	125	230	230	10	0	110
#8	235	130	130	235	235	100	110	0

Source: composed by the authors.

chemicals, fertilizers, sowing and cultivation. According to the farmers, these trainings were carried as information session, does not much help them when it comes to application of this knowledge. For example, farmers mentioned that they do get information on pollination so that it was difficult to carry out appropriate procedures. Some farmers also highlighted the fact that though they follow the procedures and information shared by the extension officer, they failed to get the expected result. Their concern was that they were not able to get information and guidance when they required as the assigned coordinator for that island was unavailable. In most cases these coordinators receive one time training which makes them less confident in addressing farmer's needs.

Indeed, the rural farming communities on Maldivian islands are geographically separated so that it requires essential time, effort, and expenses to outreach these rural farming communities by both sea and air transport. All of the above disadvantage farmers in accessing agricultural related information and markets. To facilitate this issue, we offer to apply the optimization model of the travelling salesman problem which can determine the shortest route for providing AES. For this purpose, we considered 8 largest islands involved in agricultural activity such as Ha. Baarah, Hdh. Nolhivran, Hdh. Nolhivaranfaru, Hdh. Vaikaradhoo, Raa. Kinolhas, L. Gan, L. Fonadhoo, N. Manadhoo. Time spent on moving between these islands are presented in Table 1.

The developed integer linear model is meant for searching a one-cycle route to visit each island within the quickest tour. For this to happen we introduced binary variables Xij which equal 1 if the tour goes from i-th to j-th point, i=1..8, j=1..8. To ensure a single entry to and exit from every island, the model variables are subject to the following restrictive equalities

$\Sigma j=1..8\ Xij = 1,\ i=1..8,$

$\Sigma i=1..8\ Xij = 1,\ j=1..8,$

$Xii = 0,\ i=1..8.$

Besides, auxiliary integer variables $2 \le Uk \le 8$, $k=2..8$, are designed to maintain a one-cycle route according to constraints

$Ui - Uj + 8\ Xij \le 7,\ i \ne j,\ i=2..8,\ j=2..8.$

Finally, given the parameters Cij from Table 1, the model objective function looks like

$\Sigma i=1..8\ \Sigma j=1..8\ Cij \cdot Xij \to \min.$

The optimal solution to the stated model was calculated by the tool Solver built in the spreadsheet MS Excel. It identified that it would take advisory officers a minimum of 825 minutes or 13 hours and 45 minutes if visiting islands according to the route

Ha.Baarah → Hdh.Vaikaradhoo →
Hdh.Nolhivaranfaru → Raa.Kinolhas →
N.Manadhoo → L.Gan → L.Fonadhoo →
Hdh.Nolhivran,

where a starting island is arbitrary.

The offered improvements are necessary but not sufficient. Indeed, the results of the interviews clearly shows that the family farming communities are in dire need of support in terms of education and technical assistance starting from sowing, cultivating, harvesting, and marketing. Besides, the appropriate agricultural information should move these small farming communities towards possible markets to achieve sustainable productivity, profits, improve livelihoods and increase household incomes.

One major issue that all the respondents raised was difficulty in selecting suitable time for sowing. Some farmers highlighted their concern over their inputs such as cow dung and other nutrients washing away due to flood and rain. Farmers still follow the traditional method of predicting weather information. Elderly farmers appeared to be unable to read and comprehend the labels and instructions of the chemical and fertilizer bottles/packets. As for these farmers, most of the labels are in a foreign language and the writing is too tiny for them to read and understand properly. Almost all the farmers agreed that they practice excessive use of fertilizers and chemicals as they do not know the accurate measures.

The respondents also complained that though in some seasons they can grow a higher yield, their produce goes to waste as they are not able to find a buyer. In most cases there is no transport option available for them to take their produce to the nearby markets. 40% of the farmers said the expense of taking their produce to the nearest possible market point exceeds the amount they receive after selling their production. Women farmers approach the middleman who buys their produce at a lower price which these farmers see as a good option as they do not have time and money to take their produce to the nearest market point.

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Table 2. Gender and age profiles of mobile phones provision among contract farmers in the Maldives

phones	females		males	
	under 40	above 40	under 40	above 40
smart	18	81	58	183
Nokia	0	28	1	90

Source: composed by the authors.

Potentially ICT plays a huge role in addressing challenges faced by the agricultural communities. Mobile technology being the most commonly used technology, is adopted by farmers all over the world as a delivery medium of agricultural related information and solutions. As in the most developing countries, the Maldives has leaped from handphones to mobile phones throughout the country with no difference between urban and rural communities. The challenges faced by the Maldivian small holder farming communities in accessing the latest relevant agricultural information is the remoteness of these rural communities and the long distance in outreaching them. The limited number of government extension workers do not have easy access to these communities. Despite the fact that these farming communities are disadvantaged due to its location, majority of the female and male farmers have access to smart phones and developed some digital skills. Given the living standards of these farmers, they all have access to the national radio and TV. However, the information provided by these sources is variable and biased against farmers. Recent studies shows that ICT is a possible means in connecting farmers in even the remotest locations by connecting through mobile phones and helping them to overcome knowledge gaps and improve their businesses [4].

Table 2 accumulates data on usage mobile technology among the interviewed farmers so that we can compare digital skills of females and males aged under and above 40. The idea was to identify relative resemblances and differences existing between patterns though in absolute figures male farmers prevail over female ones.

Such analysis was conducted via the chi-square test for independence of two categorical variables with two grades. The considered frequencies available from Table 2 were denoted as N11, N12, N21, and N22. To calculate chi-square value of X^2calc we employed the following formula

$$X^2\text{calc} = \Sigma i=1,2\ \Sigma j=1,2\ (Nij\ N - (Ni1 + Ni2)(N1j + N2j))^2 / ((Ni1 + Ni2)\ (N1j + N2j)\ N),$$

where $N = N11 + N12 + N21 + N22$.

The respective critical chi-square value of $X^2\text{crit}(df, \alpha)$ should be consistent with degrees of freedom $df = 1$ and a conventional level of significance $\alpha=0.05$. In case of the true inequality

$$X^2\text{calc} \le X^2\text{crit}(df, \alpha)$$

we concluded about the examined categorical variables being independent and vice versa.

Firstly, this method was applied to compare access to smart phones among females and males who are under and above 40 years of age. The performed analysis based on the inequality

$$1.40 = X^2\text{calc} \le X^2\text{crit}(df, \alpha) = 3.84$$

revealed that the explored variables of gender and age are statistically unrelated with regard to the farmers' provision with smart phones.

Secondly, the chi-square test for independence was used to examine relationship between availability of phones and gender affiliation of the farmers who are above 40 years old. Similarly, according to the inequality

$$1.93 = X^2\text{calc} \le X^2\text{crit}(df, \alpha) = 3.84,$$

there is no statistically significant relationship between the compared categorical variables. Thus, both Maldivian female and male farmers use mobile phones in the same fashion.

Therefore, in spite of a higher number of males and aged farmers involved in farming, it is justified to improve providing AES for the whole rural farming communities in a uniform way. Given the fact that 78% of female-farmers and 73% of male-farmers have access to smart phones, ICT can be used to provide these farming communities access to urgent agricultural information which might be a successful solution to address the concerns farmers have raised. Access to the internet is available to all Maldivians regardless how remote the island is. That is why in order to encompass all members of farming communities with both smart and Nokia phones we advise implementing text messages. The content of these text messages can be tailored as follows [4; 10; 16].

Firstly, it is worth providing monitoring cultivation, harvesting and application of fertilizers and chemicals. Indeed, the major challenge identified by the farmers of both genders is unavailability of support when it is required from sowing to the harvesting point. This challenge can be faced by sending required relevant information to these farmers through messages based on the digital photos shared. In this way with one click farmers can clarify the field related issues by sending a picture.

Secondly, crisis management information also matters. The Maldivian farmers experience two monsoon periods. They include dry and rainy seasons and both of them possess threat to the small holder farming communities such as outbreak of certain crop specific pest and plant diseases. These two seasons also favors certain

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crops to be grown depending on their nature. Through mobile applications farmers can be given alert on such crises and information on what measures to be taken to prevent these crises from developing. This will greatly reduce farmers loss and prepare them for planning and managing their farming activities.

Thirdly, weather forecasts should be maintained on a regular basis. Over the past two years the country faced unpredictable weather conditions such as a flood, high waves, and heavy rain. Any abrupt change in weather conditions in neighboring countries has a ripple effect on the Maldivian weather conditions creating a huge loss of agricultural produce and a consequent decrease in the livelihoods of the farming communities. Through mobile digital services, current or forecasted weather information can be shared among the farmers without much interaction between the provider and consumer. This will prevent farms from making decisions based on rumors or past experiences.

Fourthly, market access services and information on pricing of agricultural products are of a top priority. One of the main purposes of contract farming model is to provide market access to the small holder farming communities. Information on market prices, demands, logistics, storage facilities and transport options that can be readily available at their fingertip will help these small holder farming communities to manage their operations and increase the quality of their produce. Moreover, this will give farmers a chance of choosing from which supplier they should get their inputs in a manner that will be the most cost beneficial to that specific farmer.

Besides, it is important to consider providing digital access to the 22% of females and 27% males who lack access to this service. AgroNAT is a 100% state bound company, through a centralized contract farming model support farmers on a credit basis. Therefore, the company can include a credit base package to the contract farmers to acquire smart phones on a 20% discount rate where the cost will be distributed for one year. A smart phone which farmers can employ to inquire farming information costs MVR3000 which is less than $200. We offer that farmers who meet 90% of the forecasted production would be given a higher discount price. For example, a farmer who produces papayas in 5000 SQFT could pay the price of the phone within one harvest which is comparatively a very small amount.

By and large, the listed recommendations and options can be implemented to enhance education and awareness of the smallholder farming community regardless of farmers' gender and age profiles.

CONCLUSIONS AND PROSPECTS OF FURTHER INVESTIGATIONS

Contract farming is a farming model that is implemented to empower the rural family farming communities to enhance their capacity of production, ensuring guaranteed source of income and market access. One of the characteristics of Maldivian contract farming is that the farmers belong to rural communities which are far away from the main market venues. This deteriorates access to contemporary information and agricultural skills which has a negative effect on the farmers' outputs, leads to poor coordination along the agricultural value chain from farm inputs to food processing and raises production costs with lower revenue left for the farmers.

The farming communities are dispersed and there is no easy access in outreaching them. The research findings show that the AES can be provided to these farming communities based on the optimal route which takes minimum time. Keeping the starting point as arbitrary, the best possible travel route includes Ha. Baarah, Hdh. Vaikaradhoo, Hdh. Nolhivaranfaru, R. Kinolhas, N. Manadhoo, L. Gan, L. Fonadhoo, Hdh. Nolhivaran and Ha. Baarah respectively.

Mobile technology has infiltrated even to the most remote rural communities. However, 80% of the rural farmers use the phone just as means to communicate with their family and friends. The AgroNAT company can face this issue through some procedures or actions such as:

— arranging a free call service number where farmers can call and inquire about farming information;

— establishing a transport link app specific to each island for the farmers respectively to keep track of the transport options available from their island to the main market point. This is to help them in planning and organizing their harvesting;

— connecting the farmers through the mobile application to the company's 'GOVAAN APP' (GA) where farmers can calculate and forecast how much they can produce at the end of each cycle, and how many plants/seeds they must sow in a specific land size to get the maximum amount of quality harvest;

— maintaining access to information specific to each crop, including how they must prepare the pits, do the sowing, and apply fertilizers and chemicals. This could be managed through the GA where once the farmer does the sowing and uploads

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pictures, he will be given a notification what must be done next including nutrient application, pruning and so on;

— installing the transportation app through which 3 or 4 days ahead of harvesting date farmers can be notified on the options available from the nearest port.

However, for these recommendations to be implemented, significant actions at institutional and political levels need to be taken. To integrate ICT in farming in the Maldives, agricultural development goals need supportive policies, regulation, and complementary investments in physical infrastructure. For example, to achieve the objective of integrating ICT in agriculture, the messages and information need to be in the native language of the Maldivian farmers and the cost of sending and receiving messages must be low/free so that farmers can use it frequently when they need it. Although much remains to be learned, they serve as sound solutions for future interventions.

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