AGRICULTURE

Cost-benefit analysis of agriculture interventions in Andhra Pradesh

Cost-Benefit Analysis

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ANDHRA PRADESH PRIORITIES — AN INDIA CONSENSUS PRIORITIZATION PROJECT

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Cost-benefit analysis of agricultural interventions in Andhra Pradesh

Andhra Pradesh Priorities

An India Consensus Prioritization Project

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Academic Abstract

The 12th five-year plan[1] aims to promote agriculture growth at the rate of 6% in Andhra Pradesh, with an overall state growth targeted at 10%, for the period of 2012-17. In the past two five year plans, the tenth and eleventh plans, the agricultural sector in Andhra Pradesh was growing at the rates of 4% and 5.3% respectively. The Government of Andhra Pradesh, GoAP (2015), has decided to design a strategy to transform the agricultural and allied sectors with specific emphasis on increasing the productivity of the crops, improving water conservation and micro-irrigation, reducing post-harvest losses and establishing processing, value addition capacity and supply chains of the identified crops. This is combined with a goal of doubling farmer incomes by 2022 as set out by the central government.

Andhra Pradesh had a total cultivated area of 6.35 million ha in 2014-15, but it has low and stagnant productivity as compared to some other states in the country. On the other hand, the cost of production is increasing (GoAP, 2015) and overall farmer incomes are low.

In this new outlook, it is important to assess how the cost of production can be reduced, yields can be enhanced and, with appropriate pricing policies, how farmers can attain improved incomes. For this study, Copenhagen Consensus and Tata Trusts had consultations with various sector experts. In Andhra Pradesh three interventions were selected to be studied for the benefit cost analysis. These three interventions are: 1) Improving the availability of certified seeds; 2) Improving mechanization through custom hiring services, and; 3) Improving the extension services in the state through the use of modern ICT tools. The benefit cost ratios of these three interventions are analyzed in this report.

To improve yields, it is important to ensure that the seed technologies, that are the outcomes of agricultural research, are widely disseminated and adopted so that they can result in gains to the farmers. Despite significant improved crop varieties, their impacts have not been fully realized by the farmers because of poor adoption rates and poor seed replacement rates.

[1] http://www.aponline.gov.in/Apportal/Downloads/Socio%20Economic%20Survey/Twelfth%20Five%20Year%20Plan(2012-17)%20A%20Way%20Forward.pdf

Government plans to improve the availability of high yielding varieties of major crops and develop village-based seed system through women self-help groups (SHGs) and by providing seed storage capacity. This will promote timely availability of seed.

The second intervention focuses on increasing agricultural productivity with mechanization. It also helps to solve the problem of the high cost of labor and the increasing unavailability of labor. But there are many small and fragmented land holdings that make the adoption of mechanization challenging. The Government of Andhra Pradesh plans to increase the level of mechanization through custom hiring centers, using public private partnerships. Government plans to establish such centers with the help of the private sector or farmers cooperatives and pilot them in selected districts as a business model (GoAP, 2015).

The third intervention focuses on relying on ICT enabled extension service. Extension services play a crucial role in supporting overall agricultural activities by taking the research, the technology and the know-how to the farmers to improve adoption. Existing agricultural extension services are being improved with the introduction of modern information and communication technologies (ICTs). This supports better delivery of relevant information to the farmers.

Policy Summary

The Problem

Improving agricultural productivity across the sectors is important in order to improve farmer incomes. Doubling the income of farmers is the most important agenda at the national level, and the state government is similarly prioritizing this. Increasing farmer incomes requires farmers to improve yields, have better productivity through the efficient utilization of resources, reduce crop losses and realize fair prices for the outputs.

This paper examines three interventions for the state of Andhra Pradesh. First one is about improving the adoption of certified seed through better seed replacement rate. The second is to increase the use of machinery through the custom hiring services. And, third is to improve the reachability of extension system services via ICT.

The three interventions are evaluated in the context of various issues which the agriculture sector faces currently. Farmers mainly use farm saved seed and unless they are replaced at regular intervals, the yield potential is not achieved. It is important to ensure that the seed technologies that are the outcomes of research are widely disseminated and adopted so that they can results in gains to the farmers. In many cases, small and marginal land holding farmers are not able to use mechanization in the fields, other than tractors. Better mechanization helps reduce the cost of production and improves yields. Extension systems need to work efficiently to ensure that famers benefit from the improvements in agricultural technologies and practices. At present the agricultural extension system is failing to reach many farmers effectively.

Intervention 1: Certified Seed Production

Overview

The National Seeds Policy 20022, clearly emphasizes that "It has become evident that to achieve the food production targets of the future, a major effort will be required to enhance the seed replacement rates of various crops. This would require a major increase in the production of quality seeds…….". The policy document also shows that there are huge yield gaps and one of the reasons for this is the low seed replacement rate (SRR which is basically a percentage of certified seeds in comparison to farm saved seeds that are sown in total crop area3) in the country. Increasing the adoption of quality seeds can increase the yield potential of crops significantly and thus, is one of the most economic and efficient inputs to agricultural development (Abebe and Amanuel, 2017, Pavithra et.al, 2017).

The need for achieving optimal seed replacement rates should be one of the focus areas, along with creating mechanisms for the distribution and storage of appropriate seed varieties (Planning Commission, 2011). A strong back up seed multiplication and distribution system is needed in order to increase the adoption and diffusion of improved varieties as a way to enhance agricultural production and productivity. The provision of greater quantities of improved seeds to farmers through efficient seed systems is a constant challenge, involving substantial resources and a range of actors. There is the continuous need to strengthen the public extension system, increasing the emphasis on information dissemination and field demonstration, as well as farmers' participatory research and training programs, to achieve higher rates of adoption (Ghimire 2015).

Implementation Considerations

Increased crop productivity is an important strategy to increase farmer incomes. Government targets include improving the seed replacement rate in the state by increasing seed production and by ensuring that the seed is readily available to the farmers. As per the government of Andhra Pradesh (GoAP 2015), the farmers of the state will be encouraged to produce their own seed through Seed Village Programme (SVP) so that quality seed is

[2] http://seednet.gov.in/PDFFILES/National%20Seed%20Policy,%202002.pdf
[3] http://agritech.tnau.ac.in/seed/seedconcepts.html#seed_replacement_rate

available at the doorstep of the farmers, at affordable prices4. The programme aims to increase the availability of certified seeds for major crops in the state as to as to improve the seed replacement rate (SRR), producing yield gains.

In this intervention we calculate the benefit cost ratio of achieving a desirable seed replacement rate which is higher than the present rate. This costs of producing and marketing more seed are taken as the main costs in the intervention. The major benefits that come from adoption of better seed varieties are improved crop productivity and improved farmer incomes. The intervention is built up over a three-year period time frame.

Costs and Benefits

Costs

Costs include two components. First is the cost of production of the additional seed required to achieve the higher SRR. This computation is done for all the major crops in Andhra Pradesh - paddy, jowar, ragi, black gram, green gram, red gram, groundnut, soyabean and sesame.

The seed rate and existing SRR for each of these crops is used to compute the additional seed requirement to achieve the improved SRR. Given the seed production cost, which is proxied by seed prices5, we calculate the cost of the intervention to achieve the higher level of SRR.

We assume that a higher SRR is achieved over a three-year period through this intervention, by making the extension, demonstration and field days more effective, so that larger numbers of farmers can adopt the modern seed varieties. Thus, the second cost component of this intervention is the cost of promotion to incease the adoption of the improved seed. This is primarily the additional extension cost that is required for the increase in land under cultivation under modern varieties. This cost is Rs 186 per hectare (Birthal et.al, 2015) for knowledge transfer resulting in enhanced adoption.

[4] http://www.ap.gov.in/wp-content/uploads/2015/11/White-paper-on-agri.-and-allied-depts.pdf

[5] http://www.fao.org/docrep/V4450E/V4450E07.htm#Pricing%20policy

Benefits

The benefit from this intervention is mainly the increased yields because of the use of certified seed. The higher yields lead to increased production and thus higher incomes. The income gain to farmers is the total benefit. Yield gains of 10% are assumed in the study. This assumption is based on a review of yield gains from several studies (GoAP, 2015; Singh and Singh, 2016; Abebe, 2017; Clayton 2009). These studies estimate a yield gain in the range of 15-20 percent because of varietal improvement and seed replacement. In this study we have only accounted for the seed replacement rate, so the estimate of a 10% yield increase resulting from the intervention is conservative.

Intervention 2: Custom Hiring Centers

Overview

The Ministry of Agriculture and Farmers' Welfare, Government of India is focusing on agricultural mechanization through custom hiring and better technology infusion. The aim is to increase the level of mechanization, even for small farms. To implement this, the Andhra Pradesh government plans to increase the focus on making available the best machinery for farming operations, including land preparation, sowing, inter cultivation, harvesting and post harvesting. Establishing Custom Hiring Centers (CHC) facilitates the availability of high cost machinery to small and marginal farmers on a hire basis 6,7.

In order to ensure that farm machinery is within the reach of small/marginal holdings, collective ownership or Custom Hiring Centres (CHCs) need to be promoted. CHCs are basically units comprising of farm machinery, implements and equipment intended for custom hiring by farmers. The Center has pools of machineries available for hire by farmers. Though certain implements and equipment are crop specific, there are other machineries which are commonly used across all crops eg. tractors, power tillers etc. (FICCI, 2015; Yes Bank, 2016; Prasad et.al, 2014)

[6] http://www.ap.gov.in/wp-content/uploads/2015/11/White-paper-on-agri.-and-allied-depts.pdf

[7] http://apagros.org/EOI%20SCHEDULE%20FOR%20CUSTOM%20HIRING%20CENTERS%20FOR%20THE%202016-17.pdf

Thus, the analysis of this intervention is about understanding the benefit and cost of establising such centers and the expected gains from the increased mechanisation.

Implementation Considerations

Farm mechanization accelerates the pace of the growth in the agriculture sector. The Custom Hiring model has the potential to be the best way to introduce capital intensive, high quality and efficient farm mechanization to small farming structures in India. But it faces constraints like the high initial cost of equipment, along with the lack of knowledge of operational aspects, maintenance and repair of the equipment. There is also a lack of awareness among farmers of the merits of Custom Hiring (Goyal et al., 2014; Yes Bank 2016; Srinivasarao et.al 2013).

To make the Custom Hiring concept successful, there is a need to study and replicate successful business models. This should take place along with incentivization and policy support for the adoption, capacity building, skill enhancement, development and promotion of farm mechanization technologies. Virtual or real consolidation of the widely fragmented and scattered land holdings in many parts of the country is required.

Government support is also required for the efficient delivery of custom hiring services for costly machinery, especially by developing the Primary Agricultural Cooperative Societies as Agro-Service Centers and fixing the hiring rates for the machinery (Singh et.al 2013).

To achieve the benefits of CHC's, the machinery needs to be used properly. For example, both the sowing of the required quantity of seed at the right depth and the uniform application of a given dose of fertilizer, can only be achieved with the proper use of mechanical devices, Srinivasarao et.al 2013. Thus, the technical experts and extension agents also have a key role in ensuring that the CHCs are working efficiently.

Costs and Benefits

Costs

The costs include the capital cost for establishing the CHCs, operational costs every year for a period of 5 years, the cost of promotion, and the administrative costs of setting up the CHCs. The unit capital cost for setting up the CHC is worked out as Rs. 15.50 lakh. This includes the cost, of different machines and implements and also the costs of construction of a workshed of 500 sq. ft (NABARD n.d). The land costs, which are not considered in the project, may however, be treated as marginal. The operational and maintenance cost of each CHC has been separately modeled to arrive at for calculating the annual recurrent cost. This comes to around Rs. 4.5 lakh in the first year assuming 75% of the total capacity utilized and around Rs. 6 lakh per year for the subsequent years. The final component of the cost side is the expenditure on promotion which has been kept as 5 percent of the total annual cost of the CHC. The annual promotion cost is Rs. 288 crore for the first year and Rs. 87 crores for the subsequent years. It is assumed that each well stocked CHC can serve approximately 500 acres of land every year and thus in Andhra Pradesh 28,679 CHCs will be required (Prasad et.al 2014). The cost calculations are based on establishing and operating this number of CHCs over a period of 5 years.

Benefits

The major benfit of CHCs is easy access to machinery, especially to small and marginal farmers. For such farmers it is economical to hire such machinery as investment in buying is neither affordable nor feasible given the small size of the holdings. The increased farm mechanisation reduces the cost of production due to reduction in the cost human labor, animal labor and also better utilization of other inputs like seed, fertilizer and manure. These benefits are based on the estimates in studies by Prasad et.al (2014) and Singh (n.d). This intervention results in the reduction in costs of: seed and fertilizer by 15%; animal labor by 60%; and human labor by 20%.

Another important benefit is income gain due to yield enhancement which is because of the efficient utilization of inputs from mechanization. We assume 2% yield gains per year over a period of 5 years.

The residual value after depereciation of the machinery has been assumed to be 10% of the capital cost at the end of the fifth year. The third and final benefit, which accrues at the end of the fifth year, is the residual value of the machinery at the CHC after five years of operation.

Intervention 3: Improving/ expanding extension services via ICT

Overview

In all the above interventions we have used extension services as a critical component to improving yields, incomes, the adoption of technologies like certified seed or machinery, and improving soil health. The extension services in India has primarily been the responsibility of the public sector. The government has a huge R&D infrastructure in the form of institutions such as the Indian Council of Agricultural Research (ICAR), state agricultural universities (SAUs) and Krishi Vigyan Kendras (KVKs). Public sector extension services in India are usually criticized for their ineffective targeting, poor reach and the huge administrative cost of delivering information (Mittal, 2012). It is important to strengthen the agricultural extension system for increasing productivity, profitability, sustainability and incomes for the farmers. The Indian extension system has undergone reforms since the late 1990s and experienced major conceptual, structural, and institutional change (Raabe, 2008). These changes were undertaken to improve the efficiency, effectiveness and timeliness of services. These reforms included the forging of public private partnership to provide extension services and strengthening the linkages between researchers in laboratories and farmers in the field.

ICT-based extension services provide an opportunity to strengthen these linkages. In India, some of the very initial models using modern techniques were the kisan call centers and village knowledge centers that were based on landlines and internet-based computer centers in villages. These were initiated mainly by the government or NGOs. Projects like the Agricultural Technology Management Agency (ATMA), e-sagu and e-choupal gave the initial thrust. During the past few years, with the increase in mobile penetration even in rural areas, there has been an evolution of ICT-based extension services models to disseminate agriculture related information. The overall goal of using the mobile phone-enabled information delivery mechanism is to have inclusive growth by reducing the knowledge gap

between large and small farmers and by creating awareness. At the national level the m-Kisan SMS Portal8 was inaugurated by the President of India on July 16, 2013. Farmers who registered on this Portal could access advisory services. This intervention aims at reaching farmers on mobile phones in the form of SMS and IVR services.

In the calculation of the BCR for this intervention, we have built up the model to assess the cost of reaching all farmers who have access to mobile phones over a period of 5 years with advisory services and the potential benefit of utilizing these services.

Implementation Considerations

ICT has the potential to transform the traditional agricultural extension system, because of its wide reach and low cost of delivering information. Despite this, there are certain constraints on the use of mobile phones for agriculture extension purposes.

The key challenge that the service providers faces is to develop content according to farmers needs and efficiently market such service among the target users (Mittal, 2012; Glendenning and Ficarelli, 2012). Mittal et al., (2010) states that mobile and internet-based information delivery models have to be complementary to conventional extension services. Mobile phone-based initiatives alone cannot play the role of extension agents. To leverage the full potential of information dissemination enabled by mobile telephony along with supporting infrastructure and capacity building amongst farmers it is essential to ensure the quality of information, its timeliness and its trustworthiness (Mittal, 2012; Glendenning and Ficarelli, 2012; Mittal and Mehar, 2013; Aker et al, 2016).

For implementation of this intervention it is important for farmers to have access to mobile phones and to have registered with the program with specific information about their cropping patterns, location and farm size. The information utilization is another important aspect of the intervention. Farmers might get the information, but they also need to put it into action to realize the benefits.

[8] https://mkisan.gov.in/Default.aspx

Costs and Benefits

Costs

The costs are calculated for the number of agricultural households that are going to receive the services. The total number of agricultural households is obtained from the Situation Assessment Survey of Agricultural Households, NSSO, (2005). This is then adjusted downwards by the number of households who have access to mobile phone. Yamano et. al 2017 estimated that 85% of rural households have access to mobile phones9.

The cost for this intervention is a sum of 3 components. First, cost of delivering agricultural advisories through SMS. Second, cost of IVRS (Integrated Voice Recording Service) Third, other cost of operations. Since agriculture is an activity throughout the year, the assumption of 200 SMS per year at the rate of Rs. 1 per SMS is added as a cost.

Based on estimates of running the mobile phone based advisory service, the operational cost is taken as $0.83 per household per month. The cost of running an IVR services is already included in the operational costs. This is based on the Cole and Fernando 2014 study of a randomized trial in Gujarat. These costs are repeated every year over a period of 5 years.

Benefits

The main benefit of improved extension services is in form of increased farmer incomes due to efficiency in production. Maini and Rathore (2011) estimated an income increase of 10-15 percent and a reduced cost of production of 2-5 percent due to from the use of ICT based information. Birthal et. al 2015 estimated the income increase due to information as 12%, though this was for all types of information, not just those delivered by ICT.

Manjappa and Yeledalli (2013) showed that the weather based agro advisories have an impact on economic gains in the range of 4.8 to 16.7 percent for various crops. In another

[9] https://updateox.com/india/state-wise-mobile-phone-users-in-india-census-2011/ Gives the census 2011 mobile users. But with the increasing growth of mobile users per year as reported in http://www.indiatechonline.com/it-happened-in-india.php?id=545 we have assumed that 85% of households have access to mobile phone.

study, Cole and Fernando (2014) estimated that households that had access to ICT based advisories have 16 percent higher profits than the control group.

We have used the benefit estimates from the Cole and Fernando (2014) study to assess the difference between the baseline and the post-intervention income. The average of small and marginal farmers is taken as the base income figure and income of large farmers have been kept out to remove any bias.

The evaluation of ICT programs, (Palmer 2014, GSMA 2015) show that only 10 percent of the households are registered users of the services in the present government program scenario. These numbers are not available at the state level. Of these only 25 percent of households are repeat users of services. Given such poor utilization of mobile based advisory services, we have built up the intervention over the 5 year period with users as 20 percent in year 1, 40 percent in year 2 and going up to 60 percent by year 5.

BCR Table

Summary Table

Intervention	Benefit (in crore Rs)	Cost (in crore Rs)	BCR	Quality of Evidence
Certified Seed Production and Promotion	6,176	401	15.4	Strong
Custom Hiring Centers	22,574	11,892	1.9	Medium
Improving/ Expanding extension services via ICT	6,250	1,003	6.2	Strong

Notes: All figures assume a 5% discount rate

1. Introduction

Agriculture plays an important role in the economy of Andhra Pradesh as 62 percent of the population is dependent on this sector for their livelihoods. This sector is growing at the rate of 5.9 percent and contributes around 27.8 percent to the Gross State Domestic Product (GSDP) (2014-15). Rice is the major crop of the state, though it has a total cultivated area of 6.35 million ha, but overall crop productivity is low, and the cost of cultivation is increasing. The Government of Andhra Pradesh vision document (GoAP, 2015), has proposed strategies for adopting best practices in the state to boost agricultural productivity and improve the livelihoods of small and marginal farmers. Several potential areas have been identified by a consultative process, and it has also emphasized improving the role of farmers producer's organizations, public private partnership and non-government organizations.

During the 12th five-year plan period of the country (2012-17), the undivided Andhra Pradesh had set annual agriculture growth target of 6 percent and an overall growth target of 10 percent per annum 10. In the past two five-year plans, the tenth and eleventh plans, the agricultural sector in Andhra Pradesh was growing at the rates of 4% and 5.3% respectively. The Government of Andhra Pradesh GoAP (2015) has decided to design a strategy to transform the agricultural and allied sectors with greater emphasis on increasing the productivity of the crop sector, improving water conservation and micro-irrigation, reducing post-harvest losses and establishing processing, value addition capacity and supply chains of the identified crops. This is combined with the goal of doubling farmer incomes by 2022, as set out by the central government.

Andhra Pradesh had a total cultivated area of 6.35 million ha in 2014-15, but it has low and stagnant productivity compared to some other states in the country. On the other hand the cost of production is increasing (GoAP, 2015) and overall farmers' incomes are low.

[10] http://www.aponline.gov.in/Apportal/Downloads/Socio%20Economic%20Survey/Twelfth%20Five%20Year%20Plan(2012-17)%20A%20Way%20Forward.pdf

In this new outlook, it is important to assess how the cost of production can be reduced, yields can be enhanced and with appropriate pricing policies, how farmers can attain improved incomes. For this study on Andhra Pradesh, Copenhagen Consensus and Tata Trusts had consultations with various stakeholders in the sector and three interventions were selected to be studied for the benefit cost analysis. These three interventions are 1) Improving the availability of certified seeds. 2) Improving mechanization through custom hiring centers, and 3) Improving the extension services in the state by use of modern ICT tools. The benefit cost ratios of these three interventions are presented in this study.

To improve yields, it is important to ensure that the seed technologies, that are the outcomes of agricultural research, are widely disseminated and adopted so that they can result in gains to the farmers. Despite a lot of improved crop varieties released for cultivation, their impacts have not been fully realized by the farmers because of poor adoption rates and poor seed replacement rates. Government plans to improve the availability of high yielding varieties of major crops and develop the village-based seed system through women self-help groups (SHGs) and by providing seed storage capacity. This will promote timely availability of seed. We have tried to assess the related costs and benefits in a scenario with increased rate of seed replacement and higher usage of certified seeds resulting in better yields.

The second intervention focuses on improving agricultural productivity with mechanization. It also helps to solve the problem of the high cost of labor and the increasing unavailability of labor. But there are many small and fragmented land holdings that make the adoption of mechanization challenging. The Government of Andhra Pradesh plans to increase the level of mechanization through custom hiring centers, using public private partnerships. Government plans to establish such centers with the help of the private sector or farmer's cooperatives and pilot them in selected districts as a business model (GoAP, 2015). In our analysis, we have modeled required number of such custom hiring centeres and associated costs and benefits.

The third intervention focuses on extension services as it plays a crucial role in supporting overall agricultural activities by taking the research, the technology and the know-how to the farmers to improve adoption. Existing agricultural extension services are being improved with the introduction of modern information and communication technologies (ICTs). This

supports better delivery of relevant information to the farmers. The current study has developed a model to assess the costs and benefits of providing the extensions services through such ICTs.

2. Data

The data on area, yield and production of major crops in Andhra Pradesh is collected from the directorate of economics and statistics (DES) publications11, Government of India. The data on prices of crops is from the publication on agricultural prices in India, DES, GoI. The cost of production data is taken from the cost of cultivation statistics published by CACP, DES, GoI12. Cost estimates on custom hiring centers is from NABARD document on CHCs. Seed replacement rate data is obtained from the National Seed Policy document13.

3. Certified Seed Production

3.1 Description of intervention

Increased crop productivity is an important strategy to increase farmer incomes. Government targets include improving the seed replacement rate in the state by increasing seed production and by ensuring that the seed is readily available to the farmers. As per the government of Andhra Pradesh (GoAP 2015), the farmers of the state will be encouraged to produce their own seed through Seed Village Programme (SVP) so that quality seed is available at the doorstep of the farmers, at affordable prices14. The programme aims to increase the availability of certified seeds for major crops in the state as to as to improve the seed replacement rate (SRR), producing yield gains.

In this intervention we calculate the benefit cost ratio of achieving a desirable seed replacement rate which is higher than the present rate for major crops of the state. This costs of producing and marketing additional seeds to reach the target replacement rate are taken

[11] https://desap.cgg.gov.in/jsp/social/agriculture%20at%20a%20glance%202016-2017.pdf

[12] http://cacp.dacnet.nic.in/

[13] http://seednet.gov.in/PDFFILES/National%20Seed%20Policy,%202002.pdf

[14] http://www.ap.gov.in/wp-content/uploads/2015/11/White-paper-on-agri.-and-allied-depts.pdf

as the main costs in the intervention. The major benefits that come from adoption of better seed varieties are improved crop productivity resulting improved farmer incomes. The intervention is built up over a three-year period time frame.

3.2 Literature Review

The National Seeds Policy 2002, clearly emphasizes that "It has become evident that to achieve the food production targets of the future, a major effort will be required to enhance the seed replacement rates of various crops. This would require a major increase in the production of quality seeds……."15. The policy document also shows that there are huge yield gaps between the states of India and also between India and rest of the world are very large. One of the reasons for these high yield gaps is the low seed replacement rate (SRR) in the country.

Quality seed is the most basic input for sustainable modern food crop production and its potential benefits are widely acknowledged (Katungi et.al, 2011). Farmers need better seeds varieties to improve crop yields. In the present context this also build resilience to climate change (Singh and Singh, 2016; Kumara 2014). Increasing the quality of seeds can increase the yield potential of the crop significantly. It is therefore one of the most economical and efficient inputs to agricultural development (Abebe and Amanuel, 2017, Pavithra et.al, 2017).

It is empirically shown that with a small increase in seed expenses from adopting modern varieties, the yield enhancement could be increased significantly (Singh, 2013; Natrajan, Jacob, & Mandal, 2009). Studies have shown substantial amount of net economic surplus from investment in seed multiplication as an economic activity (Tripp 2000, Furtas 201, Rao et.al 2003)

It is estimated that the direct contribution of quality seed alone to the total production is about 15-20 percent, depending upon the crop. This can be further raised up to 40-50 percent with effective management and using other inputs. However, the yield potential

[15] http://seednet.gov.in/PDFFILES/National%20Seed%20Policy,%202002.pdf

cannot be realized if due care is not taken regarding varietal and physical purity, seed health and vigor.

Low seed replacement rate (SRR) remains one of the hindrances to introducing high yielding varieties. In India, farm saved seed (FSS) is the most prominent source of seed for staple crops. More than 70 percent seed usage, particularly for food crops, is through FSS resulting in low SRRs. SRR has a strong positive correlation with the productivity and production of crops. The trend of using farm saved seed continues despite the introduction of a good variety of seeds in the country (Pattanaik, 2013, Clayton, 2009). This need to change in order to improve the crop productivity. The need for achieving optimal seed replacement rates should be one of the focus areas along with creating mechanisms for the distribution and storage of appropriate seed varieties (Planning Commission, 2011).

The availability of certified seed is a big bottleneck to the adoption of improved seed. The Planning Commission, Government of India in its mid-term appraisal of the 10th Five Year Plan (2002-07) has concluded that, with respect to seed, despite the public and private sector institutional framework for seed production, availability of good quality seeds continues to be a problem for farmers (National Seed Plan, 2002). To increase the adoption and diffusion of improved varieties to enhance production and productivity, a strong back-up of a seed multiplication and distribution system is needed. Abebe and Amanuel (2017) mention that when there are different seed sources available and farmers can access them, there is high probability of adoption of improved varieties. Enhanced seed availability though formal or informal or both sources will improve smallholder farmer's access to seeds and improve variety adoption. Seed information is transmitted through informal channels in addition to the government extension system (Joshi et. al., 2007 and Yadav et. al., 2010).

The provision of increasing quantities of improved seed to farmers through efficient seed systems is a constant challenge, involving substantial resources and a range of actors. Pal and Tripp (1998) examined the flow of information about seed markets to farmers and found that inspite of the constraints there is a significant transfer of information through diverse means. In particular, farmer to farmer interactions gradually raise awareness about the availability and benefits of modern seed varieties. They do emphasize that lack of appropriate

mechanisms for diffusing such information may mean that much of the investment in public agricultural research is not able to achieve its desired impact. Emerick et al (2016) show that farmer field days lead to 40% adoption of a new seed variety after one year. Thus, there is continuous need to strengthen the public extension system, increased emphasis on information dissemination, field demonstration, and farmers' participatory research and training programs to achieve higher adoption (Ghimire 2015).

3.3 Calculation of Costs and Benefits

3.3.1 Costs

Costs include two components. First is the cost of production of the additional seed required to achieve the higher SRR. This computation is done for all the major crops in Andhra Pradesh- paddy, jowar, ragi, black gram, green gram, red gram, groundnut, soyabean, sesame

Seed rate and existing SRR for each of these crops is used to compute the amount of additional seed requirement to achieve the improved SRR. Given the seed production cost, which is proxied by seed prices16, we get the cost of the intervention to achieve the higher level of SRR. The current and target SRR is given in table 1.

We assume that the intervention achieves a higher SRR in next three years by improving the reach of extension services, demonstration and field days resulting in a, a large number of farmers adopting modern seed varieties. The higher SRR, from the desirable range of SRR listed in the seed rolling plan of Andhra Pradesh, is based on evidence from the literature that the availability of extension services significantly increases the adoption of modern varieties among farming households (Kaliba et.al, 2000, Ghimire 2015, Mignouna et al, 2011). Kaliba et.al (2000) shows that increases in the intensity of extension services increased the average proportion of land allocated to improved varieties by 66 percent. Similarly, Mignouna et al (2011) also emphasized that strengthening extension services can increase adoption of modern varieties by 44 percent.

[16] http://www.fao.org/docrep/V4450E/V4450E07.htm#Pricing%20policy

Thus, the second cost component of this intervention is the cost of promotion to improve the adoption of the more modern seed varieties. This is primarily the additional extension cost that is required for the increase in land under cultivation with modern varieties. This cost is taken as Rs. 186 per hectare (Birthal et.al, 2015), as the cost of knowledge transfer for enhancing adoption. The total cost of this intervention comes to around Rs. 400 crores. Cost breakdown by seed and promotion costs for important crops in Andhra Pradesh are presented in Table 1 below.

Table 1 – Cost breakdown of seed production and promotion by crop type

Type of Crop	Current seed replacement rate (%)	Seed replacement rate from increased extension (%)	Cost per kg of seed (Rs / kg)	Total costs new seed per year (Rs crore)	Total costs of promotion per year (crore)
Paddy Variety	92	100	33	57.3	6.5
Jowar Variety	66	80	48	0.2	0.1
Ragi	53	80	28	0.2	0.3
Red gram/ gram	82	90	39	2.6	0.8
Black gram/ urad	70	80	61	6.1	0.9
Green gram/ moong	58	80	87	15.7	1.7
Groundnut	66	80	78	301.0	4.8
Soybean	50	80	48	15.8	0.9
Sesame	41	60	128	1.5	0.4

3.3.2 Benefits

The benefits in this intervention are mainly due to increased yields because of the use of certified seed. The higher yields lead to increased production and thus better incomes. The income gain to farmers is the total benefit. A yield gain of 10% is assumed in the study. This assumption is based on a review of yield gains from several studies (GoAP, 2015; Singh and Singh, 2016; Abebe, 2017; Clayton 2009). These studies estimate a yield gain in the range of 15-20 percent because of varietal improvement and seed replacement. In this study we have only accounted for the seed replacement rate, so the estimate of a 10% yield increase resulting from the intervention is conservative. Benefits by crop type are presented in Table 2.

Table 2 – Annual benefits from increased use of certified seed

Type of Crop	State wide Increase in production from increased use of certified seeds (tonnes)	Price (Rs / tonne)	Increase in income (Rs. Crore)
Paddy Variety	1323494.5	20346.4	2692.8
Jowar Variety	11374.8	18060.2	20.5
Ragi	20891.4	24941.3	52.1
Red gram/ gram	51380.0	115485.8	593.4
Black gram/ urad	49572.4	115485.8	572.5
Green gram/ moong	63976.4	115485.8	738.8
Groundnut	294259.0	48435.5	1425.3
Soybean	112200.0	31476.0	353.2
Sesame	5520.8	65238.3	36.0

3.4 Assessment of Quality of Evidence

There is wide consensus that use of certified seeds is a key input into improving crop production. There is also literature that examines how use of extension services improves SRR at scale which are generally consistent with each other. Thus, the estimation is valued as strong

4. Custom hiring centers

4.1 Description of intervention

Farm mechanization in operations like tillage and seed-bed preparation, sowing/planting, inter-culture, fertilizer application, irrigation, harvesting, post- harvest operations, leads to agricultural growth through efficient utilization of inputs. (Dhiman and Dhiman, 2015). With newer technologies like zero tillage, land laser levelers, seed drillers, raised bed planting etc., farming has become more dependent on mechanization. Adoption of mechanization helps in timeliness of agricultural operations, it further reduces the cost of production and increases crop yield (Dhiman and Dhiman, 2015, FICCI, 2015; Yes Bank, 2016; Prasad et.al, 2014; Verma, 2006).

The Ministry of Agriculture and Farmers' Welfare, Government of India, is focusing on agricultural mechanization through custom hiring and better technology infusion. The aim is to increase the level of mechanization, even on small farms. To implement this, the Andhra Pradesh government plans to increase the focus on making available the best machinery for farming operations, including land preparation, sowing, inter cultivation, harvesting and post harvesting. Establishing Custom Hiring Centers (CHC) facilitates the availability of high cost machinery to small and marginal farmers on a hire basis 17,18.

In order to ensure that farm machinery is within the reach of small/marginal holdings, collective ownership or Custom Hiring Centres (CHCs) need to be promoted. CHCs are basically units comprising of farm machinery, implements and equipment intended for custom hiring by farmers. The Center has pools of machineries available for hire by farmers. Though certain implements and equipment are crop specific, there are other machineries which are commonly used across all crops eg. tractors, power tillers etc. (FICCI, 2015; Yes Bank, 2016; Prasad et.al, 2014)

Thus, the analysis of this intervention is about understanding the benefit and cost of establising such centers and the expected gains from the increased mechanisation.

4.2 Literature Review

India is one of the largest manufacturers of tractors in the world, but the power availability within the country is low. Mechanisation is largely happening in the big land holdings and is still beyond the reach of over 80% of the small/marginal holdings, because of poor affordability. In recent times with increasing cost of manual labor, non-availability of labor and government schemes to provide credit has institutionalized the availability of machines through CHCs (Dhiman and Dhiman, 2015, FICCI, 2015; Yes Bank, 2016)

[17] http://www.ap.gov.in/wp-content/uploads/2015/11/White-paper-on-agri.-and-allied-depts.pdf
[18] http://apagros.org/EOI%20SCHEDULE%20FOR%20CUSTOM%20HIRING%20CENTERS%20FOR%20THE%202016-17.pdf

Custom hiring of farm machines was first introduced in Indian agriculture through the establishment of the Agro-Industries Corporation (AIC) in 1960's which largely concentrated on
land development and tillage operation aspects (Nissa et.al 2017).

In 2010, under the National Innovations on Climate Resilient Agriculture (NICRA), CHCss were launched across 100 KVKs. The purpose of doing it through the KVK's was to utilize the existing technical manpower and extension agents at the KVK's and to be able to put back the revenue generated through the centers to the society (Srinivasarao 2013; Prasad et.al 2014). Under the programme, farm machinery service centers and farmer committees are formed and the requirement of individual village/agro-climatic zone is assessed. The use of equipment is tailormade as per requirement/demand

The use of mechanical power has a direct effect on agricultural productivity, apart from reducing the drudgery and facilitating timeliness of agricultural operations. Farm mechanization aims to enhance the overall productivity by reducing the costs of production (Verma 2006).

Several studies (Singh and Singh, 1972; NCAER, 1973 and 1980; Singh and Chancellor, 1974; Srinivas Rao 2013; Prasad et.al 2014) have found that mechanization leads to higher yields and increases farm output. The use of tractors enhanced agricultural productivity due to better seed-bed preparation, timeliness of operations and precision in distribution and placement of seed and fertilizer. Studies have also indicated that mechanization helps in improving cropping intensity.

Among all the states, Punjab has the highest level of mechanization. In Punjab, about 90-95 percent of combine harvesters are operated on a custom hiring basis, which reduces the cost and increases the availability of these expensive machines to the small farmers. (Dhiman and Dhiman, 2015)
In a meta-analysis by Verma 2006, he found that an NCAER (1980) survey shows an increase in cotton productivity by 7 % because of mechanization. It also estimated a 63 % higher gross income per hectare on tractor operated farms. ITES, Madras (1975) shows the use of

tractors has led to an increase in farm productivity, though the increase was better on tractor owner farms than the custom hiring farms. This is mainly attributed to higher level of input use and better control on timeliness of operations. Use of zero-till fertilizer seed drill system, improves water savings by 21 percent (Singh et al., 2014). Farm mechanization seems to have non-significant effects on human labor displacement by reducing the use of animal labor by 60 to 100%. It further leads to increases in human labor employment for on-farm and off-farm activities because of manufacture, repair, servicing and sales of tractors and improved farm equipment. NCAER (1974) reported that the tractor farms secured 21% more income per hectare of gross cultivated area compared to bullock farms.

S.E. Johnson 19 traced the increase in the yield of crops, due to mechanization of farms, by 40 to 50 per cent in the case of maize; 15 to 20 per cent in Bajra and Paddy; 30 to 40 per cent in Jowar, Groundnut and Wheat. On average, the income from agriculture is observed to rise by an average of 16% in Madhya Pradesh because of the CHCs (Tewari 2015). Prasad et.al 2014 shows impacts based on the evaluation of the NICRA village CHCs. They observed 11-13 % increases in soybean yield as well as improved conservation of valuable top soil from erosion. Reduction in costs of production and increases in grain yield by 17% - 40%. In wheat crop, there were yield gains of 10% and reductions in costs of up to 25% for seeds, irrigation water by 30% and saved time required for irrigation. Singh, (n.d). suggested that mechanization through CHCs can lead to overall saving in seeds by 15-20%, fertilizer 15-20%, time 20-30%, labor 20-30%, as well as increases in cropping intensity by 5-20% and higher productivity 10-15%.

Studies (Verma 2006; Prasad et.al 2014) also concluded that farm mechanization led to overall increase in inputs because of higher average cropping intensity, but input use efficiency has improved.

Challenges with CHC's

[19] http://www.economicsdiscussion.net/india/farming/mechanization-of-agriculture-meaning-benefits-and-progress/21655

The custom hiring model has the potential to be the best way to introduce capital intensive, high quality and efficient farm mechanization to the small farming structures in India. But it faces constraints like the high initial cost of equipment, along with the lack of knowledge of operational aspects, maintenance and repair of the equipment. There is also a lack of awareness among farmers of the merits of Custom Hiring (Goyal et al., 2014; Yes Bank 2016; Srinivasarao et.al 2013).

To make the Custom Hiring concept successful, there is a need to study and replicate successful business models. This should take place along with incentivization and policy support for the adoption, capacity building, skill enhancement, development and promotion of farm mechanization technologies. Virtual or real consolidation of the widely fragmented and scattered land holdings in many parts of the country is required.

Government support is also required for the efficient delivery of custom hiring services for costly machinery, especially by developing the Primary Agricultural Cooperative Societies as Agro-Service Centers and fixing the hiring rates for the machinery (Singh et.al 2013).

To achieve the benefits of CHC's, the machinery needs to be used properly. For example, both the sowing of the required quantity of seed at the right depth and the uniform application of a given dose of fertilizer, can only be achieved with the proper use of mechanical devices, Srinivasarao et.al 2013. Thus, the technical experts and extension agents also have a key role in ensuring that the CHCs are working efficiently.

4.3 Calculation of Costs and Benefits

4.3.1 Costs

The costs include the capital cost for establishing the CHC's, operational cost every year for a period of 5 years and the cost of promotion and administrative cost of setting up the CHC's. The unit capital cost for setting up the CHC is worked out to Rs. 15.50 lakh, which includes cost of construction of a workshed of 500 sq. ft (NABARD n.d). The land cost which is not considered in the project may however, be treated as marginal. The break up of the total capital cost alongwith the list of items that would be available in a CHC is given in table 3.

Table 3: Cost of Items in a Custom Hiring Centre (Capital Cost)

Sl. No.	Items of Investment	Cost (Rs)
1.	Tractor - 35 hp	490000
2.	Trailer	1,10,000
3.	Implements	
a	Mould Board Plough	26,000
b	Cultivator - 9 tyne	30,000
c	Cage Wheel - 18"	30,000
d	Disc harrow	30,000
e	Seed Drill	30,000
f	Accessories	12,000
	Sub Total	758000
4.	Transplanter	200000
5.	Power Tiller - 13 HP	150000
6.	Multi Crop Power thresher with electric motor	80,000
7.	Winnower	8000
8.	Self Propelled Reaper - 3.5 HP	90,000
9.	Sprayer : Powered - 1 No.	8000
10.	Sprayer : Manual - 2 No.	5000
11.	Servicing tools	4000
12.	Tools for repairing of machines	22000
	Sub Total	567000
	A shed for keeping the tools and machinery - 500 sq. ft. @ Rs. 450 psf	225000
	Total Cost for Unit	15,50,000

Source: Agricultural Machinery Custom Hiring Centres (CHC) Model Scheme, NABARD

A set of machines can serve approximately 500 acres of land in a year and thus in Andhra Pradesh an approximate 28679 CHC's are required (Prasad et.al 2014). The cost calculations are based on these number of CHC being established and operational over a period of 5 years. The detail of operational cost is given in table 4.

Table 4: Annual Operational Cost of Custom Hiring Centre

Sl. No.	ITEM	Cost	
1	TRACTOR	Full capacity Utilisation	75 % during Ist year
	Driver's Salary @ Rs.7000 per month	84000	63000
	Fuel Cost	136500	102375
	Lubricants @10%. of fuel cost	13650	10237.5
	Repair and maintenance charges @ 10 % of cost of tractor and equipment	75800	56850
	Sub Total	309950	232463
2	POWER TILLER		
	Driver's Salary @ Rs. 7000 per month for 6 months	42000	31500
	Fuel Cost	68250	51187.5
	Lubricants consumption @ 10 % fuel cost	6825	5118.75
	Repair and maintenance @ 10 % of cost of power tiller	15000	11250
	Sub Total	132075	99056.3
4	POWER THRESHER		
	Repair and maintenance @ 10 % of the cost of power thresher *	8000	6000
	Sub Total	8000	6000
5	WINNOWER		
	Repair and maintenance @ 10 % of the cost of winnower *	800	600
	Sub Total	800	600
6	SELF PROPELLED REAPER		
	Driver Salary @ Rs. 7000 per month for 3 months	21000	15750

	Fuel Cost	13000	9750
	Lubricants consumption @ 10 % fuel cost	1300	975
	Repair and maintenance @ 10 % of the cost of reaper	9000	6750
	Sub Total	44300	33225
7	SPRAYER		
	Repair and maintenance cost @ 10 % of the cost of sprayer *	1300	975
	Sub Total	1300	975
8	Other recurring cost		
	Salary for the skilled mechanic and helper to be employed for repairing work @ Rs. 5000/- and Rs.3000/- per month resp.	96000	72000
	Insurance premium @ 2% of machinery cost	11340	11340
	Sub Total	107340	83340
	TOTAL RECURRING COST	603765	455659

* the power and labour are arranged by the beneficiary hiring the equipment.

Source: Agricultural Machinery Custom Hiring Centres (CHC) Model Scheme, NABARD

The other cost is the government operational (promotion) cost which is assumed to be 5% of the total cost.

4.3.2 Benefits

The major benfit of CHCs is easy access to machinery, especially to small and marginal farmers. For such farmers it is economical to hire such machinery as investment in buying is neither affordable nor feasible given the small size of the holdings. The increased farm mechanisation reduces the cost of production due to reduction in the cost human labor, animal labor and also better utilization of other inputs like seed, fertilizer and manure. These benefits are based on the estimates in studies by Prasad et.al (2014) and Singh (n.d). This intervention results in the reduction in costs of: seed and fertilizer by 15%; animal labor by 60%; and human labor by 20%. The total annual benefit due to reduction in cost of production is Rs. 3564 crores.

Another important benefit is income gain due to yield enhancement which is because of the efficient utilization of inputs from mechanization. We used 2% yield gain per year over a period of 5 years. The total annual benefit due to yield gain is Rs. 1570 crores.

The residual price of the machinery after five years of usage has been assumed to be 10% of the capital cost. The third and final benefit, which accrues at the end of the fifth year, is the residual value of machinery at the CHC after five years of operation. This gives a benefit of Rs. 1.6 lakh at the end of the fifth year of the intervention.

4.4 Assessment of Quality of Evidence

Limited literature is available on the benefits due to CHC's. Estimates on gains because of overall mechanization are used for computations. Thus, the estimation is valued as medium.

5. Improving/ Expanding extension services via ICT

5.1 Description of intervention

In all the above interventions we have used extension services as critical component to realize the impact on yields, incomes, improving adoption of technologies like certified seed

or machinery or improving soil health. The extension services in India had primarily been the responsibility of the public sector. The government has huge R&D infrastructure in the form of institutions such as the Indian Council of Agricultural Research (ICAR), state agricultural universities (SAUs) and Krishi Vigyan Kendras (KVKs). Public sector extension services are usually criticized for their ineffective targeting, poor reach and the huge administrative cost of delivering information (Mittal, 2012). It is important to strengthen the agricultural extension system for increasing productivity, profitability, sustainability and incomes for the farmers. The Indian extension system has undergone reforms since late 1990s and experienced major conceptual, structural, and institutional change (Raabe, 2008). These changes were undertaken to improve the efficiency, effectiveness and timeliness of services. These reforms included the forging of public private partnership to provide extension services and strengthening the linkages between researchers in laboratories and farmers in the field.

ICT-based extension services provide an opportunity to strengthen these linkages. In India, some of the very initial models using modern techniques were the kisan call centers and village knowledge centers that were based on landlines and internet-based computer centers in villages. These were initiated mainly by the government or NGOs. Projects like Agricultural Technology Management Agency (ATMA), e-sagu and e-choupal gave the initial thrust. Since past few years, with the increase in mobile penetration even in rural areas, has led to evolution of ICT-based extension services models to disseminate agriculture related information. The overall goal of using the mobile phone-enabled information delivery mechanism is to have inclusive growth by reducing the knowledge gap between large and small farmers and by creating awareness. At national level the m-Kisan SMS Portal[20] was inaugurated by the President of India on July 16, 2013. Farmers registered on this Portal get advisories. This intervention aims at reaching to the farmers through advisories on mobile phone in the form of SMS and IVR services.

[20] https://mkisan.gov.in/Default.aspx

In the calculation of BCR for this intervention, we have built up the model to see what will be the cost of reaching to all the farmers who have access to mobile phones over a period of 5 years to provide advisories and what is the potential benefit of utilizing the advisory.

5.2 Literature Review

Knowledge and communication is an important resource for agriculture and can contribute substantially to ensure food security and sustainability by creating awareness and skill development through access to information. Research, extension, literacy and infrastructure have been identified as the most important sources of growth in productivity Mittal and Kumar, 2000. The World Development Report 2008 (Jock R. Anderson (2007) emphasized that agricultural extension plays a key role in agricultural development and in promoting sustainable, inclusive and pro-poor economic development.

The expected impact of different types of information are on an increase in productivity, through informed decision making about crop choice, seed varieties, agricultural inputs, agronomic practices and plant protection. Information also helps in reduction in production costs through the adoption of improved and quality inputs and technologies, and better management practices and it helps in strengthening the market information that helps in better price realization. However, the impact of mobiles as a mode of providing information for farming will depend on how mobile networks are able to link the farmers to all the required information in a timely and accurate manner. (Aker, 2011; Mittal and Mehar, 2013). The contribution of use of mobile phones can be felt at all the stages of the agriculture cycle; the impact has been in terms of both quantifiable (increase in income, improved yield etc.) and non-quantifiable gains (social benefits of improved communications, information about education and health etc.) (Bhatnagar, 2008). Information is one of the key inputs to productivity growth (Anderson and Feder, 2007).

Few studies have shown the impact on income by efficient utilization of mobile phones or mobile based information services for agricultural purposes. Daniel et al., (2011) in an action research conducted in Tamil Nadu using ANOVA method found that the farmers who received agricultural information were able to get an additional Rs 475 (US$10.5) per acre in

a 4-month duration of a season. The study found that in favorable years this can even double up to Rs 1,000 (US$22.2) per acre. A randomized evaluation of the introduction of a mobile phone-based agricultural consulting service, Avaaj Otalo (AO), to farmers in Gujarat, showed that the programme led to management practices change which lead to increases in yield for cumin by 26.3%, and for cotton by 3.5%. Overall the study found that each dollar invested by a farmer in the service generates a return of $10 (Cole and Fernando 2014).

A broader examination of the effect of information (Birthal et al 2015) suggests use of information leads to 12% higher net returns per hectare, which in value terms translates to rupees (Rs) 1140 per hectare of cropped area at 2002–2003 prices.

Constraint to adoption

ICT has the potential to transform the traditional agricultural extension system, because of its wide reach and low cost of delivering information. Despite this, there are certain constraints on the use of mobile phones.

The key challenge that the service providers faces are to develop content according to farmers needs and to market that service to the farmer efficiently (Mittal, 2012; Glendenning and Ficarelli, 2012). Mittal et al., (2010) states that mobile and internet-based information delivery models have to be complementary to conventional extension services. Mobile phones-based initiatives alone cannot play the role of extension agents. To leverage the full potential of information dissemination enabled by mobile telephony along with supporting infrastructure and capacity building amongst farmers it is essential to ensure the quality of information, its timeliness and trustworthiness (Mittal, 2012; Glendenning and Ficarelli, 2012; Mittal and Mehar, 2013; Aker et al, 2016). The economic sustainability of these extension models depends on the benefits generated and the efficient functioning of support from all the stake holders in the system. The flow of information should be complementary to existing sources of information and has to be cost effective Deichmanna et al (2016). Birthal et al 2015, suggest that investment in extension leads to higher returns than the expenditures on extension which is net Rs 186 per hectare and thus investments should be made on improving efficiency of extension to realize its full potential.

5.3 Calculation of Costs and Benefits

5.3.1 Costs

The costs are calculated for the number of agricultural households that are going to get the services delivered. The total number of agricultural households is obtained from Situation Assessment Survey of Agricultural Households, NSSO (2005) and is . This is proportioned by the number of households (85%)21 who have access to mobile phone. Yamano et. al (2017) also estimated that 85% of the rural households have access to mobile phones.

In the costs we have three components. 1) cost of delivering agricultural advisories through SMS. 2) Cost of IVRS (Integrated Voice Recording Service) 3) Other cost of operations. Since agriculture is an activity across the year the assumption of 200 SMS per year at the rate of Rs. 1 per SMS is added in the cost.

Based on estimates of running the mobile phone based advisory the operational cost is taken as $0.83 per household per month. The cost of running an IVR services is already included in the operational costs used in this. This is based on the Cole and Fernando (2014) study of running the randomized trial in Gujarat. These costs are repeated every year and thus are built up for over a period of 5 years.

The evaluation of ICT programs, (Palmer 2014, GSMA 2015) show that only 10 percent of the households are registered users of the services in the present government program scenario. These numbers are not available at the state level. Of these only 25% households are repeat users of services. Given such poor utilization of mobile based advisory services, we have built up the intervention over the 5 year period with users at 20 percent in year 1, 40 percent in year 2, and up to 60 percent by year 5.

[21] https://updateox.com/india/state-wise-mobile-phone-users-in-india-census-2011/ Gives the census 2011 mobile users. But with the increasing growth of mobile users per year as reported in http://www.indiatechonline.com/it-happened-in-india.php?id=545 we have assumed that 85% of households have access to mobile phone.

5.3.2 Benefits

The main benefit of improved extension services is in form of increased income. The Maini and Rathore 2011 paper estimated an income increase of magnitude 10-15 percent and reduced cost of production of 2-5 % is estimated. Birthal et.al 2015 estimated the income increase due to information as 12%.

Manjappa and Yeledalli (2013) study showed that the weather based agro advisories have an economic gains impact between 4.76 to 16.66 % based on the crops that households cultivated. Cole and Fernando 2014 study estimated that households that had access to ICT based advisories have 16 % higher profits than the control group. Thus, for this calculation we used the 16% profit figures on the base profit income of the households. The average of small and marginal farmers is taken as the base income figure to remove the bias because of large farming households, Rs. 37,370 per household per year

Table 5: Costs and Benefits of Expanding Extension Services via ICT

	Year 1	Year 2	Year 3	Year 4	Year 5
Eligible HHs (Number of HHs with mobile phones)	5,135,620				
% coverage	20%	40%	60%	60%	60%
HHs covered	1,027,124	2,054,248	3,081,372	3,081,372	3,081,372
Costs (Rs. crore)	99	197	296	296	296
Benefits (Rs. crore)	614	1228	1842	1842	1842

5.4 Assessment of Quality of Evidence

The evidence on the intervention is consistent and points towards benefits similar in magnitude and of the same sign (positive). Costs come from a carefully surveyed randomized controlled trial and are consistent with costs from other interventions. Thus, the quality of evidence is strong.

5. Conclusion

Three interventions in the agricultural sector for Andhra Pradesh were analyzed in this paper. The first intervention seeks to improve the seed replacement rate by increasing the production and availability of certified seed. Seed is one the crucial inputs in increasing

agricultural productivity. The BCR is 15.4 and the ratio shows the importance and overall gains by prioritising higher seed replacement rates.

The second intervention is establishing of CHC's to increase mechanization. The BCR is 1.9 and it should also be a propriety area for the AP government. This is an important initiative, but due to high costs of machinery, the benefits-to-costs are low. That said, the net benefits of this intervention are the highest out of those examined in the paper.

The improvement of extension services by introducing advisory services through mobile phones is a small step towards improving the reach of extension services. Nevertheless, this third intervention can play a catalyst role in strengthening the existing extension system. In addition, it is repeatedly emphasised that strengthening extension services will also help to improve the benefits to farmers through other interventions. The BCR for this intervention is 6.2.

Summary Table

Intervention	Discount Rate	Benefit (in crore Rs)	Cost (in crore Rs)	BCR	Quality of Evidence
Certified Seed Production	3%	6,296	409	15.4	Strong
	5%	6,176	401	15.4	
	8%	6,004	390	15.4	
Custom hiring centers	3%	23,894	12,425	1.9	Medium
	5%	22,574	11,892	1.9	
	8%	20,800	11,168	1.9	
Improving/ Expanding extension services	3%	6,666	1,070	6.2	Strong
	5%	6,250	1,003	6.2	
	8%	5,693	914	6.2	

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Sector Expert Review

Andhra Pradesh Priorities
An India Consensus Prioritization Project

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Even as the average farm size in India has declined from 1.41 hectares in 1995-96 to 1.15 hectares in 2010-11 as per the Agricultural Census, and the contribution of agriculture sector to the country's Gross Domestic Product stood at a mere 13% in 2015-16, its significance to fighting rural poverty cannot be overemphasised. Successive studies have established that the positive impact of agriculture growth on poverty reduction is twice as much as the rest of the economy. More importantly, the agriculture sector continues to support employment for a good 55% of the country's working population. Keeping this critical role of agriculture in view, Government of India (GoI) has committed itself to doubling the farmers' income by 2022.

2. Whether or not farmers' real incomes would get doubled by 2022, remains to be seen. The Committee on Doubling the Farmers' Income is, however, convinced after detailed studies, investigations and deliberations with experts and stakeholders at various levels, that the way forward to overcoming the current agrarian distress, is to reduce the cost of cultivation, increase productivity, manage both production and marketing risks and revamp the extension system to make it more market and agribusiness oriented. Reducing the cost of cultivation calls for more efficient input delivery systems to farmers that not only ensure timely availability of high quality inputs like seed, feeds, fertiliser, plant protection chemicals, vaccines and appropriate farm implements and agriculture machinery, but these inputs should be reasonably priced as well as consumed at optimum levels. For this to happen as well as to empower the farmer with information and knowledge of progressive package of crop and animal husbandry practices at one end and access to markets and remunerative prices for the farm produce at the other end, a significant reorganisation of the agriculture extension system becomes a key concern.

3. In this context, the initiative of the India Consensus Prioritisation Project to evaluate the Cost-Benefit Analysis of three select agriculture development interventions in Andhra Pradesh must be seen as a welcome support for policy options and choice. The three schemes include the Seed Village Programme (SVP); establishment of Custom Hiring Centres (CHCs) to facilitate availability of high cost machinery to small and marginal farmers on hire basis; and the m-Kisan SMS Portal where registered farmers are provided farming related advisories on mobile phone in the form of SMS and IVR services. Though these three schemes implemented by the Government of Andhra Pradesh were evaluated for their costs and benefits in the Andhra

Pradesh state, the findings are relevant to farmers and policy makers, elsewhere in the country where similar schemes are extensively under implementation. The provision of high quality seed and planting material has been found to yield the highest benefit to cost ratio (BCR) followed by the provision of extension services through mobile phone. Though the BCR of the Custom Hiring Centres is low as per the study report, apparently due to the high initial investments involved, farmers all over the country have demonstrated keenness to embrace more mechanisation of farming practices due rising wage levels coupled with labour shortages during peak seasonal operations.

4. The study brings home the realisation for all stakeholders of agriculture development that the state must ensure availability of quality seed to farmers at affordable price to check dependence on farm saved seed and to improve the seed replacement rate (SRR). The country now acknowledges in retrospect that the Green Revolution of the 1970s was essentially a 'gene revolution' achieved through the introduction of high yielding varieties of wheat and paddy sourced from the institutions of the Consultative Group on International Agriculture Research (CGIAR). Both the SVP and CHC schemes have the potential to increase livelihood security for millions of farm households, particularly self-help groups of women, who can be encouraged to produce, process and package quality seed for sale and distribution among small and marginal farmers, making them independent of private dealers and their exploitative trade practices. Good quality seed also contributes to higher cropping intensity, besides productivity.

5. The National Commission for Farmers constituted in 2004, three decades after the National Commission on Agriculture, drew the nation's attention to ten major goals which included a minimum net income to farmers, mainstreaming the human and gender dimensions, attention to sustainable livelihoods, fostering youth participation in farming and post-harvest activities, and brought focus on livelihood security of farmers. The need for a single market in India to promote farmer-friendly home markets was also emphasised, as a pathway to mitigating the farm distress. Yet, a strategic architecture to revive the farmers' sagging confidence and pride and a long-term agenda for competitiveness of Indian agriculture, remains elusive. While this study has examined the BCR of mobile phone based agriculture advisory services, the need for deep seated agriculture extension reforms cannot be overemphasised in today's scenario as farmers are ventilating their distress through extreme measures such as recourse to violence

and suicides. The new direction for the extension system is to make it more market savvy and farmer centric, suitably leveraging the information and communication technologies.

As a new state, Andhra Pradesh faces a bright future, but it is still experiencing many acute social and economic development challenges. It has made great strides in creating a positive environment for business, and was recently ranked 2nd in India for ease of doing business. Yet, progress needs to be much faster if it is to achieve its ambitions of becoming the leading state in India in terms of social development and economic growth. With limited resources and time, it is crucial that focus is informed by what will do the most good for each rupee spent. The Andhra Pradesh Priorities project as part of the larger India Consensus – a partnership between Tata Trusts and the Copenhagen Consensus Center, will work with stakeholders across the state to identify, analyze, rank and disseminate the best solutions for the state. We will engage people and institutions from all parts of society, through newspapers, radio and TV, along with NGOs, decision makers, sector experts and businesses to propose the most relevant solutions to these challenges. We will commission some of the best economists in India, Andhra Pradesh, and the world to calculate the social, environmental and economic costs and benefits of these proposals

For more information visit www.APpriorities.com

COPENHAGEN CONSENSUS CENTER

Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.

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