Report on:

Business models for scaling Climate Smart Agriculture in Bihar, India

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Submitted by:

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Abstract

Bihar is one of the poorest, most populous states in India. The populations are mainly rural dwellers and are dependent on agriculture production, as a means of subsistence and as revenue. Bihar (or more generally the entire eastern Indo Gangetic Plains of India) is composed of small scale (less than a hectare) and fragmented farm holding with poor access to new technologies. (Arya J.P. 2015) As well as being extremely vulnerable to climate change and frequent climatic aberrations (floods, drought and weather volatility), Bihar is also hindered by natural resource degradation and a lack of knowledge and development opportunities. (S.Lopez Ridaura 2014, NAFCC 2016) Introducing climate-smart practices and technologies to male and female farmers and promoting business models with the best up-scaling potential can increase the resilience and adaptive potential of agriculture in Bihar. Farmer's adoption of CSA technologies and practices could be enhanced through the involvement of CSA service providers or entrepreneurial farmers. Indeed, sustainable business models linking farmers and private sector have the potential to benefit all CSA-value chain stakeholders. CSA practices provide both farmers and service providers with the opportunity to better manage risks, to save labor and costs and to increase revenues. (Sharma 2015)

To determine the feasibility of this research, a socio-economic survey will be carried out in the Samastipur and Vaishali District of Bihar on 17 different service providers (i.e. small businesses) leasing or providing CSA technologies and machineries. This MSc Climate change, Agriculture and Food Security (CCAFS) research project will identify existing and potential business models that can support scaling-up and scaling-out of CSA practices and technologies in Bihar. These business models will be assessed using the business model canvas as it presents the global strategy to a well-established business. It details all parts of the company, showing revenues, costs, preconditions and partnerships required but it also underlines potential risks and benefits of the business for all stakeholders. (Groot 2016) Templates of the canvas business model will be incorporated into the analysis. It will allow us to evaluate current and potential effects of the adoption of business models promoting CSA practices and technologies, on both service providers (SPs) and customers (male and female farmers). (Groot 2016)

This project “Business models for scaling Climate Smart Agriculture in Bihar, India” is part of the CCAF-CGIAR project P53-FP1-SA-CIMMYT “Recommendation domains incentives and institutions for equitable local adaptation planning at sub-national level and scaling up CSA practices in wheat and maize systems”.

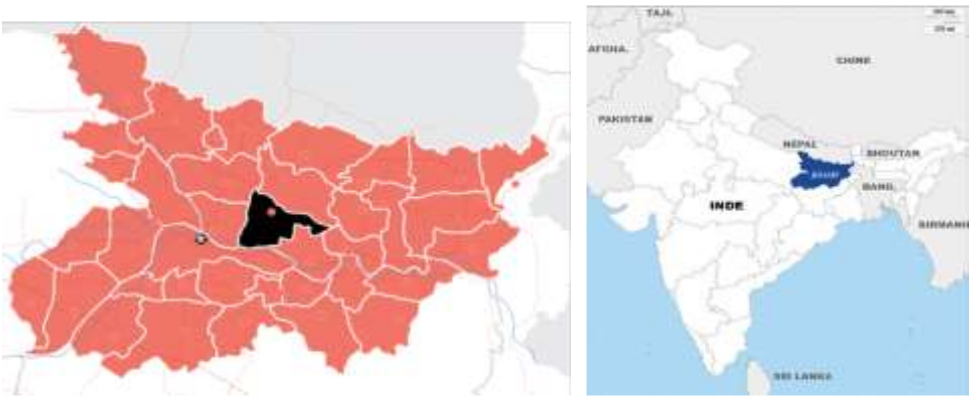


Figure 1: *District of Samastipur, Bihar, India (source: FAO, Wikipedia)*

Introduction

General context and Climate-smart Agriculture:

Within 2050, the world population is expected to reach up to 10 billion and this growth, linked to our means of production and consumption will have critical impacts on ecosystems, agriculture and climate change. A business-as-usual scenario would lead to an increase of more than 2°C in world temperature and would have dangerous consequences on biodiversity and food security. (B.M. Campbell 2014) This rising temperature is arising mainly due to our GreenHouse Gas (GHG) emissions with the agriculture sector responsible for 19 to 29% of all world emissions, mainly due to deforestation, over-used land and fertilization management. (B.M. Campbell 2014, Arslan, McCarthy et al. 2015)

Certain parts of the world are already under high levels of food insecurity and climate change is likely to reduce agricultural productivity and production stability, making them even more vulnerable. Although crop yields have impressively increase during the last decades, crop yields are still required to increase by 60-70% by 2050 to meet the future demand. The agricultural sectors must become climate-smart to successfully adapt to current and future food security and climate change challenges. (Lipper, Thornton et al. 2014)

Climate Smart Agriculture (CSA) is an approach that aims to develop a more environmentally sustainable agriculture, under the new realities of climate change. (B.M. Campbell 2014, Lipper, Thornton et al. 2014) The three pillars of Climate-smart agriculture (CSA) are productivity, adaptation and mitigation. This means increasing quality and crops' yields, enhancing farmers' resilience and adaption to current and future climate change consequences, while reducing or removing GHG emissions from this production when possible. Those practices aim to sustainably establish food security for all populations and particularly those most vulnerable to food scarcity and extreme climate change related events. However, some trades-off have to be made, for instance, increasing crop yield and resilience while reducing GHG emissions often can't be achieved simultaneously. (Verchot 2007, Lipper, Thornton et al. 2014) This is particularly evident in countries suffering from chronic poverty, periodic extreme events or food and water scarcity. The biggest challenge in the CSA approach is to identify potential trade-offs and prioritize actions in order to ensure sustainable development. Implementing climate-smart agriculture can be a major driver of a greener economy and a concrete way to establish sustainable development. (FAO 2013, B.M. Campbell 2014, Lipper, Thornton et al. 2014)

Agriculture and food systems have to transform in order to meet the current and future challenges of food security and climate change. Mechanization of farming system in vulnerable countries has an important role on resilience and adaptation increase for small holder farmers, especially in poor and rural areas depending mainly on agriculture. CSA practices and technologies are working within an ecosystem approach, by increasing resource efficiency and by building climate change resilience while increasing productivity. It is crucial for all stakeholders to respond to climate change impacts and also to contribute to mitigation among the most vulnerable populations. (Verchot 2007, FAO 2016)

Increasing access and availability of these CSA technologies would have an important impact on labor, yields and income. It would increase livelihood and resilience of smallholder farmers. (FAO 2013, Meryl Richards 2014, Taneja G. 2014) These climate-smart technologies (CSTs) promote better soil practices, resources management, labor saving and better yields. They are often leased to farmers by private sector entities (service providers, entrepreneurial farmers...) or bought by a group of farmers or even farmer communities (Climate-smart villages...). These CSTs are often hardly available or accessible in developing countries due to the high prices of purchasing and the lack of financial opportunities (credit, subsidies, loans…).

In order to help communities to increase their adaptive capacity and to have a major development impact, significant behavioral shifts at various levels are required. CSA approaches also integrate government and institutional participation as they can support the scaling of interventions. This link requires innovative policies that benefit farmers and increase their capacity to practice CSA (social policies such as index based insurances, loans or subsidies...). These policies provide a means for farmers to minimize their losses and to practice sustainable production through the use of climate-smart technologies (CSTs) for instance. (FAO 2007, B.J. Barnett 2008, FAO 2013)

Concepts and Methodology:

CSA in Bihar and Placement project

Indian context

India is located in South Asia and is home to over 1.2 billion people, making it the world's second-most populous country. Bihar is a state in the north east of India, composed of 38 districts and it is the third most populous state in India, but only the 13th-largest state by area. It lies on the river plains of the river 'Ganga' (the Indo-Gangetic Plains (IGP)) and has a tropical climate with a minimum temperature of 11°C and a maximum temperature of 39°C with an average rainfall of 1100 mm a year. Its population demonstrates a very low literacy rate (63,8% in 2013), with castes culture and traditions still present among the population (Bihar population is mainly represented by a "lower caste"). The IGP climate projections for 2050 at a glance are shown in figure 4. In India, climate change threatens the population at all levels and impacts are already visible according to the IPCC. It has and will continue to have dangerous consequences on food security, health and environment. (Taneja G. 2014, Arya J.P. 2015)

A large part of the population of Bihar is rural, mainly dependent on agriculture production (estimated to be 81% of the population), for subsistence and as means of revenue. About 42 % of the state population suffers from severe and chronic poverty. As well as being extremely vulnerable to climate changes and volatility, Bihar is also hindered by natural resources degradation and by lack of knowledge and development opportunities. Moreover, the absence of proper land records and ownership are slowing down any potential development. The lack of machinery, improved seeds or appropriate natural resource management skills are leading to low yields, inducing food scarcity and low revenues. Indeed, yields of rice, wheat, maize or sugarcane could be increased by at least 30% in some regions. (S.Lopez Ridaura 2014, Taneja G. 2014, Arya J.P. 2015) Introducing CSA practices and technologies to men and women farmers has the potential to increasing the resilience and adaptive capacity of agriculture in Bihar.

Climate-smart project in Bihar

In India, mainly in Haryana's district, already 27 Climate-smart Villages (CSVs) are created, and disseminate key climate-smart agricultural interventions, focusing on water, energy, nutrient, weather and knowledge implemented through innovative partnerships and farmer cooperatives and are having a successful impact on the population's livelihood and development. These villages promote sustainable intensification and conservation agriculture-based management systems through the adoption of CSA practices and technologies. They are important vehicles to put CSA theory into action.

In 2005, the International Maize and Wheat Improvement Center (CIMMYT) created a research center and a partnership with the agricultural university of Pusa in the Samastipur district in the Bihar region of India. They worked with farmers and service providers (SPs) on practices and technologies inducing better yields and better soil, water and labor management but also increase farmers resilience and adaptation. The Borlaug Institute for South-Asia (BISA) was created in 2011 and they implemented a farm in Pusa for research purposes on practices and technologies that would benefit Bihar's farmers, and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) linked also to this project in 2012. The project "Business models for scaling Climate Smart Agriculture in Bihar, India" is part of the CCAF-CGIAR project P53-FP1-SA-CIMMYT "Recommendation domains incentives and institutions for equitable local adaptation planning at sub-national level and scaling up CSA practices in wheat and maize systems" and works to develop business models at climate-smart village sites as a strategy to scale CSA technologies and practices in South Asia.

During the summer 2017, a survey was carried on SPs leasing of providing climate smart machines, where 17 different business models were assessed. During this survey, a range 40 wide-answers questions were asked to the SPs on their CSTs, on their customers and on the financial aspect of their business model. This survey aims to find an existing or a potential business model supporting scaling CSA in the region. By doing semi-structured interviews with SPs, we identified the activity, the revenues and all costs of the business and we highlighted limiting factors, precondition required and risks for both customers and SPs. We tried to understand their perception on climate variability and its potential effects that it would have on their business model. This survey shows the interest of the private sector to sustainable farming practices and technologies, which can induce better link between private sector parties and small holder farmer. It can facilitate a sustainable way of moving to scale for all stakeholders.

Thanks to this survey and the Data collected, we are able to separate different types of business models depending on their available opportunities, their access to financial support and their link to the government of Bihar. We shall describe and define these model types in order to identify the best existing and potential business models that can support the scaling of CSA practices and technologies in Bihar.

Semi structured survey

The Survey was made on 17 service providers (SPs) in Samastipur and Vaishali District in Bihar, India. These SPs were selected from a list, provided by scientists from BISA farm, regrouping all SPs owning CSA machines and technologies and working with the CIMMYT/BISA institute. There was no hierarchy or special order in the conducted survey, we interviewed the SPs that were available first. A semi structured interview of 40 open questions was conducted. These questions were established to fulfill a Canvas business model for each business assessed. Each survey was conducted at the SP's house or his farm but also at BISA farm directly. Surveys last between 45 to 75 minutes maximum and a translator was helping with the understanding of all parties. The translator was generally Dr Deepack from the CCAFS program at BISA farm. (Photos 1)
The SPs that were surveyed were originally farmers and were leasing or providing non-CSA machines and technologies such as cultivator or rotavator machines. The knowledge and some CSA machine were brought by CIMMYT and BISA through interventions, trainings and demonstrations.

Photos 1: *Survey and semi-structured interview with service providers in Bihar (source: personal pictures)*

a. Canvas business model

The Canvas business model is a visual chart that critically assesses business models. Starting from a value proposition, it shows through 9 basic building boxes the whole process and organization of the business. It highlights cost and revenue streams, as well as pointing out who are the customers and what are the channels of communication and service. It includes elements such as markets, partners, key activities or key resources required to a proper effective business. (Figure 2) The canvas business model assists the creation and the establishment of a business and can show barriers, trade-offs and challenges, helping decision makers. Indeed, many factors and limits can impact the success of a sustainable innovation (as competition, real demand, funding…). This is why it is required to highlight these factors as soon as possible during the creation of a new business. By identifying these limits and factors we can define how a potential business model would impact the adoption and diffusion of the product (or service, but here an innovative technology). (IFAMA, 2016)

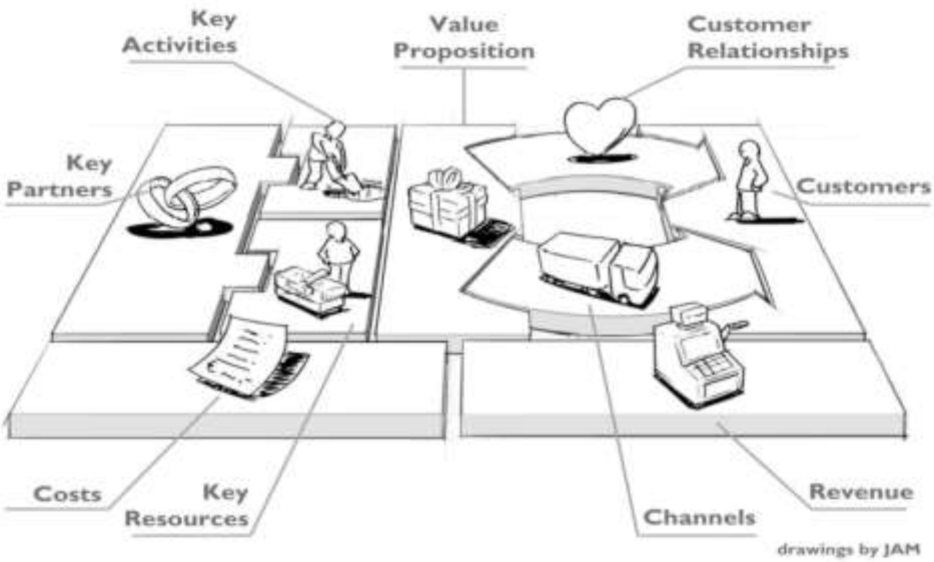


Figure 2: *Canvas Business model (source: Strategyser)*

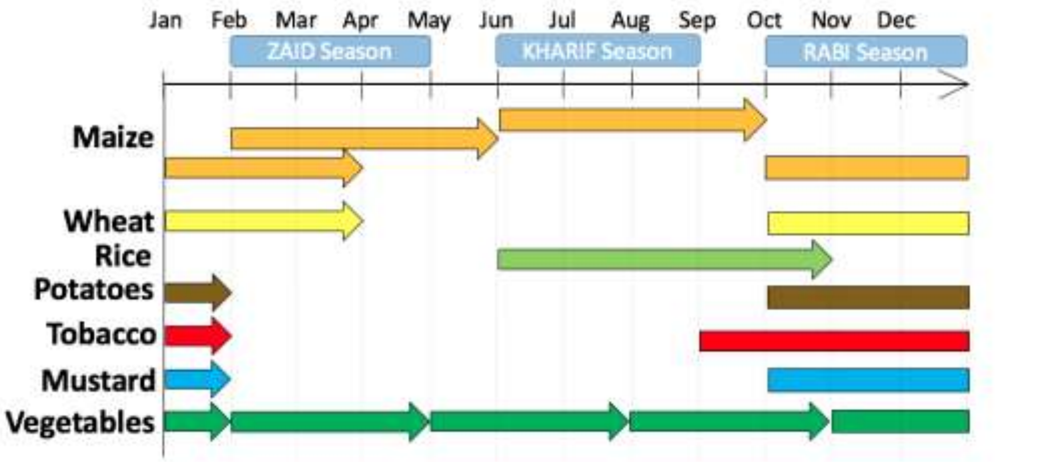
Farming practices and technologies

Agriculture still represent 16% of the Indian's Gross domestic product (GDP) today, which is an important part compare to Europe for instance, where agriculture represented only 1,9% of the total GDP in 2016. Thus, the Indian economy is still relying on agriculture which means that climate change and its consequences will have important impact on Indian's economy in the years coming. Farming systems in India are separated on three different types, subsistence farming, organic farming and industrial or intensive farming. India is the second biggest producer of wheat, rice, cotton, sugarcane, silk, groundnuts, and a lot more. During our survey, we encountered mainly households doing subsistence farming.

In Bihar, as we can see on Figure 2, there are 3 crop seasons, determined by the climate and the monsoons, the ZAID, KHARIF an RABI season. During the surveys carried with the SPs, we separated 7 types of crops, (Maize, Wheat, Rice, Potatoes, Tobacco, Mustard and Vegetables) produced at different season of the year with different technologies and machinery. The main issue is the region is the rainfalls volatility and the floods created by heavy raining events. Thus, crops the most dependent on green water, which means water coming from the rainfalls, such as rice crop, are the most vulnerable crops to climate change and climatic aberrations. CSA practices and technologies work within an ecosystems approach, by increasing resource efficiency and by building climate change resilience while increasing productivity. They allow famer to be more capable to resist and to adapt in front of climate change and extreme climate aberrations.

In Vaishali and Samastipur districts, there is not climate smart technologies (CSTs) available for each cropping system, thus, SPs can purchase new technologies mainly for Wheat, Rice, Maize and Potato. The main reason is to reach higher income and to reduces human labor. More, in order to be more resilient in front of climate change and variabilities, farmers tend to prefer technologies more respectful of natural resources and with a better resilience and adaptive potential. We assessed in detail each and every of the 19 machines they used, 12 of them are CSTs and 7 are non-CSA technologies. We asked for price of purchase, maintenance, profitability, maximum use, life expectancy and more as we can see in the Table 1. Price of machines are in Indian rupees (INR) where 1€ worth 75 INR and 1 lakh is equivalent of 100.000 INR.

In order to use these machines, tractors and tralors are necessary but both represent a major expense for SPs to purchase and to maintain. Tractor's maintenance expenses increases along the years, even more with non-adapted storage facilities that bring to major maintenance issues (which is often the case as sheds are not always affordable). To make the business profitable and in order to be able to use more than one machine at a time, SPs need more than one tractor and tralor. But depending on their access to loans and on their business expansion, it can be hard for SPs to purchase new tractors.



Graphic: Time repartition of seasonal crops during the year in Samastipur and Vaishali District in Bihar, India.

Vegetables: cauliflower, cucumber, mug beans, eggplant...

Non-climate-smart technologies:

Except one, all service providers have Cultivators and Rotavators machines and 7 of the 17 SPs also own Disc plough and Disc harrow machines, which are non-CSA technologies. (Photos 2) Those non-CSA machines are disturbing soil ecosystem (loss of soil organic matter), they are degrading the soil through tillage and compaction that leads to loss of soil fertility and biodiversity. Plus, they are not energy efficient as they are burning a lot of fossil fuel to run (12 to 25 liters per hectare). More, farmers often need to use those machines many times (3 to 5 times per field) which lead to high greenhouse gas emission for only one crop field. These machines are commonly used in Bihar and are a solution to labor scarcity in the region, but are not helping to increase resilience and adaptation of small holder farmers to climate change.

These non-CSA technologies were SPs' main business before CIMMYT/BISA intervention and there are still a lot of SPs providing these technologies even in the climate smart villages working with CYMMYT/BISA. Competition is an important factor that strongly impacts non-CSA businesses and all SPs told us during the surveys that they consider competition as their main factor on which depend non-CSA technology businesses. Their net income loss due to competition can be up to 70% before they moved to CSTs.

***Photos 2**: Climate smart machines in Bihar, India. Cultivator (left), Rotavator (right) (source: personal pictures)*

Climate smart Technologies and machines

Climate smart technologies are promoting a minimum soil disturbance by minimizing or avoiding tillage, reducing soil compaction and reducing inputs (or improving its use and application). Some CSTs are improving water management, can ensure uniformity of crop moisture (field leveling) and increase soil fertility. It also decreases energy use (fossil fuel mainly) which has consequences on GHG emission reduction that CSA practices is promoting.

There is a labor scarcity issue in the agricultural sector in Bihar. Labor requirement is problematic for farmer who need men's labor on fields but also on machines. Indeed, more and more people are leaving rural areas for more urbanized towns, or are simply stopping their agricultural activity. Farming is considered as a difficult job that does not provide sufficient salary and also as a major climate dependent job (Climate and weather that are quite variable a year to another in these areas). Thus, there are also less and less farmers, which means also less and less customer's demand for our SPs.

All SPs surveyed have moved to CSTs thanks to CIMMYT and BISA intervention. The natural resources conservation and greenhouse gas emissions reduction aspect of these CSTs is not the main reasons for SPs to purchase them. They moved or added CSTs to their business mainly because of the machine efficiency, because of the farmers' demand (created by CIMMYT and BISA trainings and demonstrations) and thanks to the subsidies from Bihar's government for climate-smart practices and technologies. Indeed, thanks to CIMMYT and BISA trainings and demonstrations on CSA practices and technologies since 2005, more and more farmers realized the CSTs potential on labor and cost saving. This increasing demand has led SPs to purchase these CSTs. The farmer's demand on CSTs is still increasing, depending on the number of demonstrations and trainings conducted.
The 3 most purchased by SPs on the 12 CSTs that were assessed, are the Zero tillage machine (ZT), the Bed-planter and the thresure machine. Indeed, all SPs have purchased at least one ZT and 4 of them have purchased more than one up to 4 ZTs. 13 SPs have purchased one to

two thresure machines and 9 SPs have purchased a multi of simple Bed-planter. 3 of the multi crop planters were CIMMYT properties and were lend to SPs to promote the machine effectiveness and to encourage them to purchase one of their own.

Zero tillage machine:

The Zero-tillage machine (ZT) (Photos 3) is a machine used for wheat-rice farming systems. It allows farmers to sow wheat without any burning of rice residues. When combined with mulching, it reduces air pollution and induces soil conservation. It also saves water, energy and labor for the farmer. The positive results and the increasing customer’s demand (men and women farm holders) created by CIMMY and BISA interventions have boosted the emergence of service providers selling and leasing the technology to farmers in the area. This machine cost 30.000 to 60.000 INR to purchase and the government of Bihar supports 50% of the price through subsidies. Purchasing second hand machines slightly cheaper (around 20.000 INR) is also a possibility but they can expect more maintenance and a shorter machine’s lifetime.

The Zero-tillage machine is profitable, really efficient and does not require a lot of maintenance (average of 500 INR per year). The farmer’s demand is increasing among farmer communities because of the cost saving and for its efficiency. Indeed, compare to non-CSA technologies, the ZT machine is used only once per crop field where cultivator and rotavator machines can be used 4 to 5 times one field. It makes the non-CSA service much more expensive at the end. However, SPs need to find more customers in order to make the ZT profitable as farmers are using it only once per crop field and are often forced to go further from their villages to find customers. Farmers and farming communities need to be convinced in order to use ZT (or even CSA practices and technologies in general) which means that more farmer trainings and demonstrations are required to make this machine as profitable as possible for the SPs. More, we can assume that the profitability of the ZT machine depends as much on the number of customers as on the land size of those customer. According to CIMMYT/BISA scientists, that this machine can covers 100 to 120 hectares maximum per season, however if this surface is highly fragmented by a large number of customers owning land of 0,5 hectare each, we can assume that the machine is not at its full potential. Indeed, we can think that the high land fragmentation in the Vaishali and Samastipur regions has an impact on the profitability of all machines (ZT machine and all the other CSTs). More questions on the minimum land size required to cover by each machine to be profitable would be relevant for a comparison of effectiveness and of profitability between each machine.

It is important to note the difference between Happy seeder machine and ZT machine even if they are quite similar but Happy seeder is destroying crop residue while sowing. Thus, Happy seeder is not used in Vaishali and Samastipur Districts because farmers are using these residues as animal fodder. We can still find some happy seeder in Bihar in some region where rain and floods have destroyed residues.

Laser Land Leveler:

We can also note an important demand of levelling in Bihar as land are often crooked and resulting with problem of water and mineral management and yield loss. The Laser land leveling (LLL), (Photos 3) is a tractor-towed, laser-controlled device that makes a crop field surface as flat as possible. It reduces the use of water for irrigation and increases crop yields. A rise of rice and wheat yields of respectively 7% and by 7 up to 9% is expected after a crop field is leveled. It is considered as a CSA technology as it improves productivity, water management (sustainable water use), and decreases the energy use and thus lowers greenhouse gas emission from agricultural activities. Even only 3 SPs own a LLL, the three of them said that it is one of their most profitable machine and they reach the maximum customers potential every year with this machine. Plus, 4 other customers are expecting to purchase one in the future if they manage to extend their business or to access to new financial support (or partnership).

However, there are some issues, according to the SPs, regarding the maintenance costs that are really high (up to 25.000 INR per year) and regarding the knowledge and the spare pieces that are difficult to find. Some SPs even had to go to New Delhi to find knowledges and spare parts for his LLL. Plus, they can have to move up to 300km away from their agency to reach the furthest customers. However, this machine is operational during the whole year as farmer need to level their land after a certain number of faming seasons or after an extreme climate event such as floods that can modify fields leveling. More, its activity is not related to forecast of weather volatility. For those reasons, we can consider the LLL as a possible machine for an potential effective and profitable business model. Plus, there are really few owners in the region which means that there is a low or even no competition for this machine.

Others CSA-Machines

The thresure machine is also quite present in the region. It is a cost, energy and labor-saving machine. It is preferred to the harvester in Bihar region as it does not destroy the rest of the crop during the harvest which allow farmers to use residues as animal fodder. However, the maintenance cost per year is quite high for this machine. (from 5000 up to 15000 INR per year, which often depend of storage facilities of the SP) Indeed, storage facilities for this machine is much important as the way it will be stored during the year will influence their life expectancy and thus its global profitability.

The rice-transplanter and the simple and the multi-bed planter are also important CSA machines in the regions and have a benefit impact on farmer resilience and adaptation to climate change. However, due to the lack of time on site, we could not gather enough information to properly assess these machines.

Profitability:

We can see on table 1, at the end of this document, that the most expensive machines to purchase and to the maintenance are the combined harvester, the tractors and the laser land leveler. However, it’s important to take into account the fuel consumption and the life expectancy of the machine in order to assess its effectiveness and its profitability. Among the 17 SPs that were interviewed, the rotavator, the ZT and the LLL are the three machines the most profitable. However, there is a growing competition on the rotavator among SPs, plus that it is not a CSA machine (so no resilience and adaptation improvement for farmers). And as we said earlier, there are issues with the availability of maintenance for the LLL, plus the big distance between SPs and their customers for this machine. As Zero Tillage machine is a low-cost purchasing and maintenance machine with many climate smart properties and advantages, we can say that it is the most profitable machine among our list for the Vaishali and Samastipur district at this moment, in August 2017.

***Photos 3**: Climate smart technologies, Zero-tillage machine (left) and Laser Land Leveler (right) (source: personal pictures, JAT and al. 2015)*

***Photos 4:** Climate smart technologies, Rice transplanter (left) and Multi-bed planter (right) (source: personal pictures)*

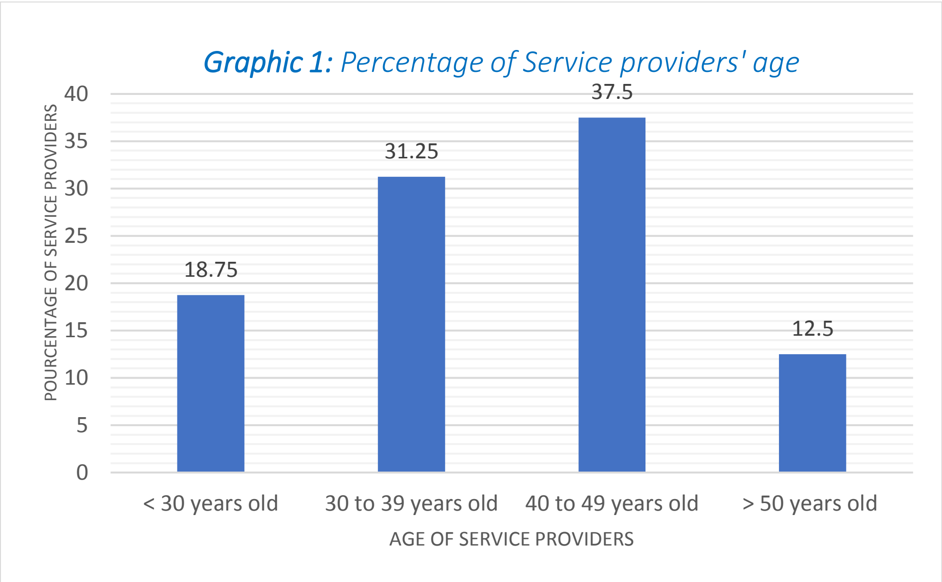
Results and discussion:

As we said before, all service providers' names and information are regrouped in the Table 2. During this part of the report, we will describe and compare business models of the 17 SPs assessed. We will highlight the big differences between them and explain the main characteristics of each business. We will finally separate 3 groups of different business models depending on its size (number of customers, machines, net income…), on the SP access to subsidies and loans or on their link with the government of Bihar. Then we made a detail analysis of the most efficient and profitable business model encountered and we represented it in a business model Canvas table (Table 3). We highlight that the third type is potentially the most efficient business model that can scale CSA practices and technologies in Bihar. But more interviews on a larger range of SPs but also interview on farmers using those CSTs provided by SPs would be required to develop the best potential CSA business model that would benefit all stakeholders

Analysis of service providers' answers to the semi-structured interview:

General information:

The Service providers assessed generally didn't know about CSA practices and technologies before CIMMYT and BISA interventions, trainings and demonstrations. They are mainly aged between 30 and 49 years old (Graphic 1) and had already experience on farming practices. We met SPs that started their CSA business 11 years ago, with the implementation of the CIMMYT in the region, and another that purchased their first CSTs only last year. Most of them had already a service business, leasing or providing non-CSA technologies to farmers in their area. We will focus on the climate-smart part of their business. We saw that there is an average of 4 persons working in each business (minimum 2, maximum 7). Those persons are usually the owner plus one partner (family or farmer) and machines drivers. They can also hire more drivers during a specific season depending on the demand.



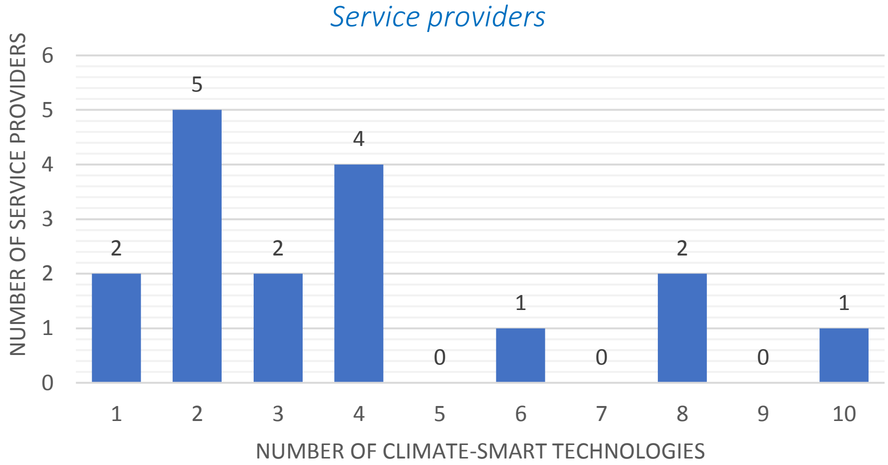
Climate smart technologies and machines

The main expenses for SPs are the tractors as they cost 3 to 9 lakhs each, depending on the size and the capacity of the tractor. Some SPs already had their own from previous businesses or from their family businesses. These tractors are necessary for the farming service business (as well as tralors) in order to use all CSA and non-CSA machines (except the Rice transplanter that has its own motor included in the machine).

The SPs that we interviewed are working on 2 up to 10 CSA machines depending on their financial opportunities and their business expansion. (Average between 2 and 4 CSA machines) Main customers of our SPs are small holder farmers. Indeed, in Bihar and more precisely in Vaishali and Samastipur district, 90 to 95% of the farmers own lands smaller than 1 hectare. Only one SP is working with farmer with land of 8 hectares average. (SP n°14) Indeed, SPs are targeting mainly bid size farm holders when they can (farmers with more than 2 hectares). It is a problem for SPs providing big CSTs (such as LLL, Multibed planter, Combined Harvester…) as well as for those who would like to invest in bigger-size CSTs, as they are more profitable on larger fields.

We asked for the number of CSA and non-CSA customers per year and per machine, but these values have been revealed irrelevant as for most of the machines, their profitability depends more on the size of the land on which they are used than on the number of customers.

Graphic 2: *Number of climate smart technologies per Service providers*



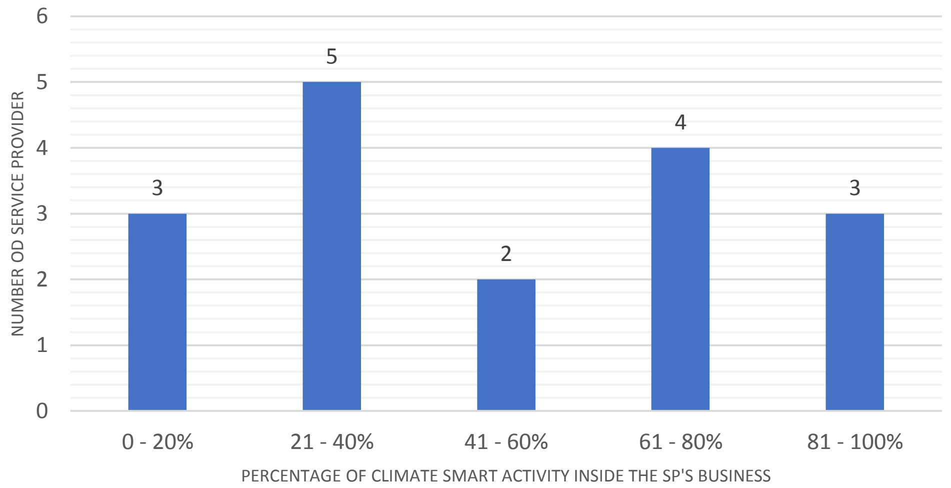
In order to answer the customers' demand and to make the machine the most profitable, SPs have to move far from their area to reach certain customers. For non-CSA machines, the demand is usually grouped around an area of 2 or 3km maximum. For small CSTs such as ZT or thresure, they have, on average, to go 10km away (up to 25km). However, for big CSTs machines such as combined harvester or LLL, SPs can have to drive 270km up to 340km away from their original area. The main reasons to this are the customers' demand for CSTs but also of customers' land-size requirement for big CSTs use. This necessary added distance compare to non-CSA machines can be revealed as a main issue for some new SPs keen to move to climate smart technologies. It can also stop some SPs promoting small CSA machine to invest into bigger one.

All SPs are declaring their CSA business profitable, plus, 14 out of the 17 SPs want to expend it with new machines and practices, in bigger areas. The financial support can also be found through partnerships with other farmers, other SPs or with some organizations such as private companies or NGOs. However, only 5 of the SPs are declaring looking for partnerships for financial reasons or for business area expansion. Indeed, SPs declared that they do not trust other farmers and SPs on business matters, and they say that they would prefer to remain by themselves.

Income and CSA net profit

We asked to service providers their net profit from last year (2016). This net profit represents the total profit made by the SP minus all expenses on maintenance and fuel for these machines during the year. We separated this question in two, comparing net revenue from CSTs and those from non-CSA technologies. We saw that 2 SPs (n° 4 and 13) are making profits only from CSTs (100% climate smart service providers) but on the contrary, 4 of the 17 SPs had their profit on less than 25% from CSTs. It can be due to the lack of advertisement on CSTs in his area, to little number of CSTs owned by the SP, or due to a really good and profitable non-CSA business. It would be interesting to assess with more precision and on a longer timeline the development and the expansion of these 100% climate-smart SPs.

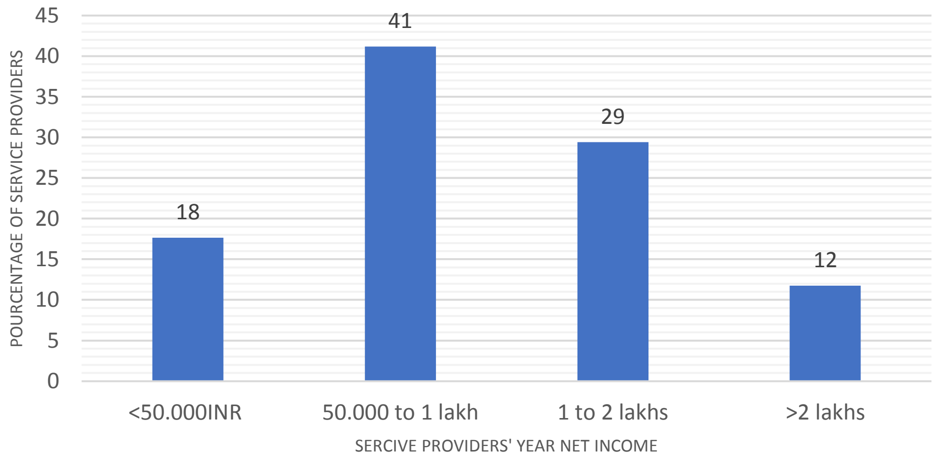
Graphic 3: Pourcentage of climate change activity inside the services providing business



We can see that SPs' net revenues from CSTs are mainly between 50.000 INR and 2 lakhs per year. However, certain SPs would not disclose their real net income in front of BISA scientists or in front of strangers. We can think that certain values are not necessarily accurate and all deductions from these net income data should be taken with precautions. According to CIMMYT/BISA scientists, a farmer would need at least 20.000 INR per month to live in Samastipur and Vaishali district with means 2,4 lakhs a year. We conclude that for a majority of the SPs that we assessed it is not possible, in the actual conditions, to live only depending on a CSA business. The customers' demand needs to increase, general awareness on CSA practices and technologies need to be developed and farmer and SPs should have access to more source of financial support in order to expend their CSA business.
For all 17 SPs, proving CSTs or non-CSA machine to farmers is their main source of revenue. But, in order to live more decently, SPs all have aside income generating activities. They are all farmers and they all can be considered as major farm-holders as they own lands of more than 1 hectares. There are 9 SPs owning land between 1 to 2 hectares, 5 that own 2 to 6 hectares and 3 SPs that own land of more than 6 hectares. These lands are used for food and cash crops during the year, but also to produce improved seeds. 10 out 17 SPs are producing and selling these improved seeds (mainly wheat and maize seeds) to farmers. Originally, those seeds were bought from BISA farm and can generate up to 50.000 INR per year as a

side activity to SPs. Otherwise, SPs can have other businesses like a poultry farm, a fish farm or a chemicals and fertilizer shop for farmers. The fish farm would be interesting to assess as it can be a potential efficient and profitable CSA activity.

Graphic 4: Representation of the number Service providers depending of their year net income



Financial source and support:

The first financial support has a major impact on the longevity of the new CSA business model. They all but one (SP n°13) received subsidies from the government of Bihar for CSA machine. These subsidies represent 50% of the machine purchasing cost. Some SPs that started CSA businesses more than 5 years ago didn't received subsidies on some machines such as the Laser land leveler, as government was not subsidizing this machine yet. All SPs that own a new Zero tillage machine received subsidies to purchase it. You cannot receive any subsidies for second hand machines.

There are 12 of the 17 service providers that took loans from national banks or from private loaning companies, mainly in order to purchase tractors, but also for the combined harvester, the LLL or for the JCB (machine that we won't talk about too much in this report). Those loans are generally on 3 to 5 years with interest of 10,5% up to 14%. 6 of the 17 SPs also used the Kiscan farmer credit card which is a credit account given by the government of Bihar for farmers. It allows farmers to borrow a certain amount of money depending the size of their land with a 3 to 4% interest rate. This amount can be up to 3 lakhs maximum. 2 SPs also said that they received money from family and friend's communities, which they have to repay later with low or no interests. Not all SPs can afford loans and their high interest rates and it's often because of this that the business expansion is limited.

Detail of the three different business models encountered:

The models encountered are differing by their age (date of creation of the business), number of customers or of land covered by machines, by net income per year or have different relation with the government of Bihar. We have assessed the 17 business models and we saw that their canvas model representations are all quite similar as they all received help from CIMMYT/BISA institute and are all using the same channels and machines for most of the SPs. This is why the link to the government and the capacity to provide packages to farmers should be assessed with more details. We need to know more about benefits and limits of packages offered by SPs and highlights what opportunities some SPs received or what decisive choices they have made in order to extend more their CSA business than other on the same amount of time. Indeed, it would be interesting to understand why some of them are more profitable after 5 years than others after 11 years. Nevertheless, we created a canvas model (on Table 3) representing the most effective business model encountered for scaling CSA in the Vaishali and Samastipur region.

First model: Small or new business models

The first model encountered is the less developed and the less efficient model. The SPs are farmers owning few non-CSA machines and having problems to make good profit out of them due to large competition on those machines in the region. They decided to move to CSA technologies thanks to CIMMYT/BISA trainings and demonstrations. They decided to purchase the least expensive CSTs such as zero tillage machine, thresure machine or simple bed planter. They find customers through demonstrations that they do before the beginning of every season to farmers. This demonstration can be done by themselves or in collaboration with CIMMYT/BISA scientists.

Due to the lack of initial finance and to the high loan's interests, they can't afford more that 2 CSTs and the business expansion is slow. They reach an average of 75% of the maximum customer potential of his machine due to the small land size of his costumers. Indeed, the smaller the lands size are, the more the SP will have to move the machines fields to fields and thus, waste potential time and profit. These SPs have usually started to purchase CSTs less than 5 years ago.

Their link to the government are only through the subsidies they receive for the CSA machines purchasing. Farmers can receive subsidies from the government if they purchase or use CSA practices and technologies. But due to the increasing number of SPs providing CSTs in the region, more and more farmers are asking access to these subsidies, and not all can access to them. A survey on the criteria to receive subsidies from the government for use of CSA services provided by SPs would be necessary. A better understanding of the subsidies distribution to farmers would help to promote the use of climate-smart practices and technologies.

This CSA business is not profitable enough yet for this SP and he often has other income generating businesses aside (farm land, aquaculture, poultry, brick industry…). A follow-up of these SPs during a longer period of time would be necessary to understand the main reason of the slow business development or to lower profitability.

In this first category, we can group service providers n°1, 4, 6, 10, 15 and n°16 that we can find on the Table 2.

Second model: Ongoing business models with expansion potential

The second model is the model the most encountered during our survey. They are previous farmers and non-CSA service providers that moved to CSA technologies thanks to CIMMYT/BISA trainings and demonstrations. It's been generally more than 5 years ago that they started to purchase and provide CSTs and now their business is expended. They received their financial support from banks, private companies or from family and surrounding friends and neighbors. They own more than two CSA machines and they can afford bigger CSTs such as Laser land leveler, Rice-transplanter or even a combined harvester.

However, they have to move further from their village to reach more customers for their bigger machines or simply to reach customers with bigger sized lands. They have access to loans and subsidies, but as loans are usually between 3 to 5 years to repaid and with important interests to the bank or to private companies, the expansion of the business can be slow.
They do not provide any packages to their customers.
In this second category, we can group service providers n°2, 7, 8, 9, 12 and n°17 that we can find on the Table 2.

<u>Third model</u>: Expended and profitable Climate-smart business models
The third model represents the most efficient model that we encountered in Bihar. SPs grouped in this category own more than five CSA machines and they can afford bigger CSTs such as Laser land leveler, Rice-transplanter or even a combined harvester. They can purchase many tractors which are the biggest expense in order to make more CSTs work at the same time. They have access to financial support from their own business profit, but also from partners and they have easier access to more important bank loans.

They can be registered officially which give them the opportunity to have more subsidies from the government. It allows farmers to receive more subsidies for the CSA services that they are providing. Some of them also propose packages to farmers on rice and wheat farming services which are 40% to 50% subsidized by government. Those packages represent a main advantage to increase access to CSTs to small holder farmers and to scale up CSA in Bihar. A larger survey including famers would be needed to understand if this link between SP and the government of Bihar allow SP's customer to access to subsidies for non-package CSA services more easily.

This kind of business model is getting closer from a business model that can have a good scaling potential of climate smart practices and technologies. However, we can note that these 5 SPs are part of the oldest to start CSA businesses in Vaishali and Samastipur. We can think that these businesses are slow to expand and that SPs from the two first categories can also have opportunities and time to grow and to become more profitable.
In this third category, we can group service providers n°3, 5, 11, 13 and n°14 that we can find on the Table 2.

A more detailed assessment of the business models from the SPs n°13 and 14 would be required to understand the main factors of success of these two CSA businesses. Their number of CSTs and their net revenue are higher than all the others SPs assessed on both of them have only 5 years of existence. This survey would also explain the main difference of net revenue that they get from CSTs during a year between the two them. Indeed, for almost the same number of CSTs, there is a difference of ten times of net revenue between the two. If this is due to the acquisition of the combined harvester by the SP n°14 that lead to this increase of net revenue, a more detailed survey should be made on this climate smart machine. Although the fact that SPs might not say their real income for different personal reasons as to be taken into account.

Most efficient model encountered:
The third business model is illustrated with the example of the 13th SP surveyed, Pashupati Kumar Raju from Darbanga Climate smart village in Darbhanga district. He is a man household of 46 years old, he started his business directly with CSA technologies in 2012. He has been introduced to CSA practices and technologies by CIMMYT/BISA trainings and

demonstrations. He still receives help and expertise for his customers from CIMMYT/BISA as they organize meetings with farmers and SPs before every season start. These meetings are useful for SPs as they are promoting machines that he provides. There are 4 employees working in the business during the year (him and 3 drivers) but he can hire more seasonally if necessary. The company is officially registered and he works also with the government on Bihar and with the agricultural university of Bihar.

He owns 4 Zero-Tillage machines, 2 rice Transplanter, 1 binder and 1 wheat Thresure. These technologies are water, cost and labor-saving services and improve farmer's resilient. When customers (men and women farmers) are coming to the SP he is providing a whole service, including tractors, tralors and the use of wanted machines. Plus, he offers packages to his customers, which can be subsidized up to 50% by the government. According to him, the ZT machine is his actual most profitable machine due to its efficiency, lower cost of maintenance every year and the large demand. He could however have more customers for ZT machine if there were more demonstrations and training as farmers need to be convinced in order to create the demand.

<u>PACKAGES:</u>

- Wheat: Seeds + pesticides + Fertilizer + Machines: 4800 INR per Acre
- Rice: Seeds + Nursery + Fertilizer + Trans planter: 3000 INR per Acre

His customers are small and medium holder farmers (from 0,5 to 5 hectares) but also farmer communities and Climate-smart villages. He promotes and work with farmer cooperatives in order to group land-fields for machines use, providing less expensive services as it is better for machines effectiveness to work on bigger land size. He had 40 customers for the Rice package and 100 customers for the Wheat package last year. Few year ago, he had up to 850 customers, but he had to hire up to 10 tractors and drivers. However, it was too much time and labor consuming to handle 850 customers, but it proves that there is a large customer's demand for climate smart technologies. Last year he reached an optimal (for him) number of customers for climate-smart services of 300 customers.

He has to go up to 25km away from his village to reach some customers. (Compared to only 1 to 2km away for non-CSA machine). Otherwise, he contacts his customers by phone, and through direct contact to his place but also through CIMMYT/BISA meetings and demonstrations. He can use internet and emails as a way of communication and advertisement, but farmers usually do not have access to such devices. There is a trust and fidelity relationship between the SP and his customers, indeed, as he is delivering service on time and giving some time the payment and the customers should be back to him next year. Plus, his costumers are favored by the fact that he has a registered company and that they can benefit of subsidies from the government for the Packages.

On the financial part, he has access to subsidies from government and loans from banks or private financial companies in order to buy his machines but mainly to buy his tractors. He currently has two loans of 3 and 5 years with 11% and 14% interest. He wants to expand his business by adding 100lakhs of investment in new machines and in partnership. He is planning to purchase a multicrop planters, a Laser land leveler, some Happy seeder machines and he wants to build new sheds and infrastructures. Plus, he wants to create a partnership with NGOs working on women farmers empowerment in Bihar (the NGO is called MGVP association) in exchange of financial support to extend his business.

Beside his CSA business he also has cultivators and rotavators machines and owns 15 Acres of land that he is cultivating (6 hectares). However, competition is quite important in the region for non-CSA machine and prefers staying focus on CSA machine as there is also a problem of labor scarcity. Competition is not affecting him regarding all CSA machines, but climate is a big factor of success every year as he is working with rice machinery that is a crop extremely sensitive to rainfall volatility. The business model of Pashupati Kumar Raju is represented in a Canvas business model on Table 3.

A new meeting with Mister Pashupati Kumar Raju would be required in order to assess with more precision the whole process of implementation and expansion over the years of his business model. Did he received more help than other SPs or maybe had access to more opportunities over the years? What is his relation with the government of Bihar and how packages are established and subsidized and on what extend? We need to understand benefits and impacts that these packages have on his own business, but mainly on farmer resilience and adaptation potential to climate change. This new assessment will allow us to evaluate the potential of this business model to scale CSA in the Vaishali and Samastipur region.

Conclusion:

Indian agriculture is likely to suffer from climate change in the next decades. Climate smart machinery and practices has been found very effective to increase resilience and adaptation of farmers suffering from climatic aberrations and weather volatility. Plus, it reduces GHG emissions from agriculture through precise land leveling, no tillage seeds planting, and crop residue management. Increasing access and adoption of these technologies and practices will enable these farmers to better manage climate related risks, it will reduce costs and increase their revenues.

We assessed 17 different business models from 17 SPs in Vaishali and Samastipur district in Bihar, India during the summer 2017. During this survey, we assessed only men service providers, as due to social issues, it is not acceptable for women to handle technical or technological businesses in the region, according to scientist from CIMMIT/BISA. We assessed SPs that were chosen from a list given by CIMMY/BISA scientists. It could be interesting to have a look on a larger group of SPs and farmers next time and to highlight the criteria of choice for these SPs for being part of the survey or if simply, it was because they were the only ones. We detailed particularities of each machine and deduces thanks to SPs' answers to the semi structured interview which one of them were the most profitable. In this certain location, as it is a region composed of small scale (less than a hectare) and fragmented farm holdings with poor access to new technologies, the most profitable CSTs for a SP to promote is the Zero tillage machine. Plus, ZT machine and the Laser land leveler are the two machines that SPs want to invest into, due to customer's demand and agricultural needs.

Farmers' demand for CSTs is increasing through the years, mainly thanks to CIMMYT/BISA intervention. Indeed, training and demonstrations from CIMMYT/BISA institutions have a major impact on SPs' business models. They create a customer demand and proved the efficiency of CSA practices and technologies to SPs and to farmers. They happen every year before every season at BISA farm or directly on farmer's field. They can regroup farmers, SPs or both, and aim to brought knowledge on practices and technologies inducing a better soil, labor and water management while keeping or increasing crop yield and reducing GHG emissions. The CIMMYT/BISA could also facilitate the creation of farmers' cooperation and community in order to group land fields and financial resources. This would facilitate the use of bigger CSTs on farmers' land. It would have a better environmental impact because of the use of more efficient CSTs, it would be more profitable for the SPs and also cheaper and easier for farmers.

There are 15 out of 17 SPs that answered that climate and weather are the most important factors on which depend their business models. It is mainly SPs providing services for the rice production that are related to climate. The region suffers of erratic rainfall and floods that can destroy a major part of the rice fields every year. A specific research on the resilience potential to weather volatility and floods of each machines over different crop seasons should be conducted. The 2 last SPs (n°15 and n°17) answered that the number of customers was their main factor of success for their business which mean that advertisement and demonstrations and necessary in these regions.

We saw that the business models the most efficient that we encountered was not an old business (5years old) and that its link to the government could have a major impact on farmers access to CSTs. Indeed, if these packages provided by this SP are more prone to receive subsidies, it will get more customers to the SP and it would be cost effective for farmer keen to use climate smart technologies. However, a survey on the criteria to receive subsidies from the government for use of CSA services provided by SPs would be necessary. A better understanding of the subsidies distribution to farmers would help to promote the use of climate-smart practices and technologies.

More, in order to create an effective potential business model that can scale up CSA in Bihar, a survey including farmers on social-economical interests and limits on CSTs would be necessary. Plus, the 100% climate-smart business models of service providers n°4 and n°13 need to be more detailed in order to follow their development during the years and their potential expansion. They would be good indicators of climate-smart business potential in the region.

References:

- Arslan, A., et al. (2015). "Climate smart agriculture? Assessing the adaptation implications in Zambia." Journal of Agricultural Economics 66(3): 753-780.
- Arya J.P., M. M. B., M. L. Jat (2015). "Impacts of laser land leveling in rice–wheat systems of the north–western indo-gangetic plains of India." Springer Science + Business Media Dordrecht and International Society for Plant Pathology 2015.
- B.J. Barnett, C. B. B., JERRY R. SKEES (2008). "Poverty Traps and Index-Based RiskTransfer Products." World Development 13(10).
- B.M. Campbell, P. T., Robert Zougmore, Piet van Asten and Leslie Lipper (2014). "Sustainable intensification: What is its role in climate smart agriculture? Current Opinion in Environmental Sustainability."
- C. Jost, F. K., Jesse Naab, Sharmind Neelormi, James Kinyangi, Robert Zougmore, Pramod Aggarwal, Gopal Bhatta, Moushumi Chaudhury, Marja-Liisa Tapio-Bistrom, Sibyl Nelson & Patti Kristjanson (2016). "Understanding gender dimensions of agriculture and climate change in smallholder farming communities." Climate and Development.
- CCAFS (2015). Scaling up Climate-Smart Villages in India, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Dannie Dinh, J. H. (2016). Climate Week NYC Panel Event: Innovative Approaches for Scaling up Climate-Smart Agriculture.
- Deepak Bijarniya, J. M. S., R.K. Jat, Tek B. Sapkota and M.L. Jat (2015). "Climate smart agricultural practices: Improving productivity, profitability and resource use efficiency of small- hold farms of Eastern Indo Gangetic Plains of India."
- FAO (2013). Climate smart agriculture Sourcebook, Organisation des Nations Unies pour l'alimentation et l'agriculture, Rome 2013.
- FAO (2016). Planning, implementing and evaluating Climate-Smart Agriculture in Smallholder Farming Systems.
- FAO, U. N. (2007). "Developing Index-Based Insurance for Agriculture in Developing Countries." Sustainable Development.
- Gopal D. Bhatta, R. S., and Patti Kristjanson (2013). Summary of Baseline Household Survey Results: Vaishali Site, Bihar State (Northeast India), CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Groot, A. (2016). Climate Smart Agriculture Practices led business cases: The Happy Seeder as example
- Groot, J. R. a. A. (2016). Lengthy list of CSA practices with potential for business development - Deliverable 5 - Project P53-FP1-SA-CIMMYT, CCAFS, Wageningen, The Netherlands.
- Gupta, P. R. H. a. R. K. (2001). RICE-WHEAT CROPPING SYSTEMS IN THE INDO-GANGETIC PLAINS: ISSUES OF WATER PRODUCTIVITY IN RELATION TO NEW RESOURCE CONSERVING TECHNOLOGIES.
- J. Rooker, A. G. (2016). Business development opportunities for scaling up climate smart agricultural practices in wheat and maize systems, Deliverable 6 - Project P53-FP1-SA-CIMMYT - Recommendation domains, incentives and institutions for equitable local adaptation planning at sub-national level and scaling up climate smart agricultural practices in wheat and maize systems. CCAFS, Wageningen, The Netherlands.
- Lipper, L., et al. (2014). "Climate-smart agriculture for food security." Nature Climate Change 4(12): 1068-1072.
- Long, T. B., et al. (2017). "Business models for maximizing the diffusion of technological innovations for climate-smart agriculture." International Food and Agribusiness Management Review 20(1): 5-23.
- Meryl Richards, T. S., Clare Stirling, Christian Thierfelder, Nele Verhulst, Theodor Friedrich, Josef Kienzle (2014). Overview of conservation agriculture - Implementation guidance for policymakers and investors, FAO.

- NAFCC (2016). Introduction of Climate Smart Agricultural Practices to improve the resilience of farmers through Mainstreaming Climate Smart Villages (CSVs) in Bihar, National Adaptation Fund for Climate Change (NAFCC).
- O. Erenstein, V. L. (2008). "Zero tillage impacts in India's rice–wheat systems: A review."
- P. Cooper, S. C., Sonja J. Vermeulen, Bruce M. Campbell, Robert Zougmoré and James Kinyangi (2013). Large-scale implementation of adaptation and mitigation actions in agriculture, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- S.Lopez Ridaura, R. F. (2014). "Characterising the diversity of farming households in the Vaishali District, Bihar, India, A typology of farm households."
- Sharma, P. (2015). Business Cases of Climate Smart Agriculture Practices: Examples in West India, Business case of Turbo Happy Seeder in Haryana, India.
- Taneja G., B. D. P., Pramod K. Joshi, Pramod K. Aggarwal, N. K. Tyagi (2014). Farmers' Preferences for Climate-Smart Agriculture and Assessment in the Indo-Gangetic Plain, IFPRI - NTERNATIONAL FOOD POLICY RESEARCH INSTITUTE. 1337.
- Verchot, L. V. (2007). "Opportunities for climate change mitigation in agriculture and investment requirements to take advantage of these opportunities." A Report to the UNFCCC Secretariat Financial and Technical Support Programme. Nairobi.
- World Bank Group, F. a. I. (2015). Gender in Climate- Smart Agriculture - SOURCEBOOK.

Technologies	Machines	Price at the purchase	Price of service	Used for which crops	Maintenance per year	Liter of fuel needed	Why is it climate smart?	Life expectancy	Time window of use
CSA	Laser Land Leveler	3,25 lakhs	650 to 700 INR per hour	All land	15.000 to 25.000 INR	7 liters per hour	Water and inputs (fertilizer, insecticide…) efficient	10 to 20 years	All year but mainly April - May - June
	Leveler	12.000 INR	600 INR per hour	All land	500 to 1.000 INR	5 liters per hour	Water and inputs (fertilizer, insecticide…) efficient	10 to 15 years	All year but mainly May - June
	Zero tillage	30.000 to 60.000 INR	2.200 to 2.750 INR per hectare	Wheat - Rice	200 to 1000 INR	7 to 10 liters per hectare	Labor and energy saving, low GHG emissions and soil conservation	10 to 20 years	October to December (Wheat) and May to July (Rice)
	Bed planter	20.000 to 70.000 INR	2.750 INR per hectare	Maize - Wheat	200 to 500 INR	7 liters per hour	Labor and energy saving, low GHG emissions and soil conservation	5 to 10 years	June to August
	Multibed planter	75.000 INR to 1 lakh	2.750 INR per hectare	Maize - Wheat (+rice)	200 to 500 INR	7 to 10 liters per hectare	Labor and energy saving, low GHG emissions and soil conservation	5 to 10 years	
	Small harvester: Binder	1,2 lakhs to 3,5 lakhs	1.500 INR to 3.000 INR per hectare	Wheat mainly (Maize - Rice also)	20.000 INR	2 liters per hours	Labor and Energy saving and cost effective	5 years	June to August
	(Combined) Harvester	16,5lakhs but can go up to 60 lakhs	2.000 INR (Rice) to 3.500 INR (Wheat) per hectare	All crop but mainly Maize, Wheat and Rice	1 lakh	2 liters per hours	Labor and Energy saving and cost effective	8 to 10 years	All year
	Rice Transplanter	2 lakhs (no tractor needed)	1.200 INR per hour	Rice	5000 INR	7 liters per hectare	Labor and Energy saving and cost effective	5 years	May to July
	Potato planter	35.000 INR	3.300 INR per hectare	Potatoes	1.000 INR to 1.500 INR	15-18 liters per hectares	Labor, Energy and Water saving and soil conservation	10 to 15 years	October - November
	Potato digger	70.000 INR	3.600 INR per hectare	Potatoes	1.000 INR to 1.500 INR	20 liters per hectare	Labor and Energy saving and cost effective	10 to 15 years	February - March
	Maize Thresure	42.000 INR	800 INR per hour	Maize	5.000 INR	4 liters per hours	Labor and Energy saving and cost effective	10 years	February and April - May
	Wheat Thresure	75.000 to 1,35 lakhs	800 INR per hour	Wheat	5.000 to 15.000 INR	4 liters per hours	Labor and Energy saving and cost effective	10 years	April to June
Non-CSA	Cultivator	20.000 to 35.000 INR	2.000 INR per hectare x many times	All land	1.000 to 3.000 INR	12-13 liters per hectare		20 years and more	all year
	Rotavator	70.000 to 1 lakh	2.750 INR per hectare x many times	All land	10.000 INR	20-25 liters per hectare		10 years	all year
	Disc harrow	30.000 INR	2.000 to 2.750 INR per hectare	All land	200 to 500 INR	15 liters per hectare		10 to 15 years	all year
	Disc plough	15.000 INR	2.750 INR per hectare	All land	200 to 500 INR	15 liters per hectare		10 to 15 years	all year
	Tractor	3 to 9 lakhs		All land	15.000 to 60.000 (+5 years) INR	6,5 liters per hectare			all year
	Tralor	2 lakhs							all year
Other	JCB	22 lakhs							Almost all year

In august 2017: 1€ = 75 INR
1 lakh = 100.000 INR

Table 1: Service provider's Climate smart and non-Climate smart technologies and machines assessed in Samastipur and Vaishali district in Bihar, India

Pashupati Kumar Raju Darbanga village - Darbanga	Student Name: PIERRE VERNET MCs ACT – NUI Galway	☒ Primary Canvas ☐ Alternative Canvas

Key Partners	*Key Activities* / *Key Resources*	*Value Proposition*	*Customer Relationships* / *Channels*	*Customer Segments*
• CIMMYT and BISA • Farmer Cooperatives • Government of Bihar and University of Agriculture	*Key Activities* • Knowledge on CSA practices and technologies provided by CIMMYT training and demonstration • Loans from banks or private financial institutions • Financial support *Key Resources* • CSA machine and technologies • Access of spare pieces for maintenance • Storage place • Human labor available (Drivers)	• Climate resilient service • Water, cost and labor-saving service • Yield improving technics through Climate smart technologies • Providing Climate smart technologies services including tractors, tralors and machines: - 4 Zero tillage machine (ZT) - 2 Rice Transplanter (RT) - 1 Wheat Thresure (WT) - 1 Binder • Packages subsidies by the government	*Customer Relationships* • Relation of mutual trust through payment credit and service on time • Contact through Phone call and texts and email when possible • Direct contact through the farmers house or the service provider's house *Channels* • Direct channels, service on farm (can go up to 25km away from office maximum)	• Small and middle-sized holder farmers (from 0,5 to 5 hectare) • Work with farmer communities and cooperatives • 300 customers per year for CSA technologies

Cost Structure	*Revenue Streams*
• Machine cost of purchasing (Once) - maintenance (every year) - ZT: 30000 to 60000 INR - 500 to 1000 INR per year - RT: 2 lakhs - 5000 INR per year - WT: 0,75 to 1,35 lakhs - 5000 to 15000 INR per year - Binder: 1,2 to 3,5 lakhs - 20000 INR per year - Tractor: 3 to 9 lakhs per tractor - 15000 up to 60000 INR per year • Machine fossil fuel and energy use • Machine purchasing (only once)	• Income generated per machine: - ZT: 2.200 to 2.750 INR per hectare - RT: 1.200 INR per hour - WT: 800 INR per hour - Binder: 1.500 INR to 3.000 INR per hectare • Net income for this CSA business: 1,2 lakhs per year • Receive subsidies • Have 2 loans on tractors (3 and 5 years loans, 10 to 14% interests) • Use of the Kiscan farmer credit card

Table 2: The business model Canvas of service provider n°13, in Bihar, India