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Mapping of Vegetable Seed Companies Willing to Adapt the Solar Irrigation System to Produce in Mali

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Abstract:

The seed producer companies are important for achieving the technology to adapt mainly through promoting their equipment for access and transportation the water resources and services. The aims of this study were to develop a better understanding the irrigation system used by the vegetable seed companies' producers, and to identify the main constraints of access to irrigation for vegetable seed production in Mali. The focus discussion was used to collect data from 9 vegetables seeds compagnies producers and descriptive statistics were performed to capture the trend values of the respondents. The results from the preliminary analysis showed that 57% of companies have never heard about gravity irrigation and 64% use this material for irrigation. About 44% have found it too expensive for their use of another method of irrigation for moving water. However, 89% of companies already know drip irrigation and 11% of them have not used it as they find because it will be too expensive for his. The lack of equipment and financial resources to move water from the source to the plant are the main constraints facing 78% of seed companies in Mali. However, 88.9% of companies have a lack of information and training for a good plant watering.

Keywords: *Irrigation system, supply and demand equipment, water economy, water application, seed compagnies.*

Introduction

The irrigation system is innovative for agriculture and has an impact on supporting irrigated vegetable seed production. Farmer preference on the use of equipment adapted to the irrigation system is a concern in most of these countries. Innovation lab scale system irrigation (ILSSI) vision is to identify opportunities and pathways to scale up by providing market evidence on irrigation equipment and initial ideas to improve market density and competitiveness for the benefit of small farmers Feed the future (2021). The literature focuses on improving the technical performance of different irrigation systems. The introduction of technological innovation in the production of maize crops in Mali has given a new lease on life to the seed producer. However,

resilience depends on capital (labor, productive, human, social, or cultural) and rights of access, use, and transmission over resources Cambrézy et Janin (2003). It is very useful to present the benefits of the new plot irrigation technology to the seed company and make it an important element in the seed production process. This does not involve detailed technical studies of the irrigation system, but first identifies the main weaknesses related to the infrastructure and prioritizes them according to their importance Apollin et Christophe 2(013).

In the Sahel, variations in rainfall and temperature induced by climate change are weakening food systems and exposing an average of 30 million people to food insecurity Verpoorten et al. (2013); Sissoko et al., (2021). Agriculture, livelihoods and Climate change in the West Africa Sahel". In Sub-Saharan Africa, the evolution of well-being and vulnerability remains contrasted Epule et al., (2017) in Climate Change Adaptation in the Sahel" Unfortunately, because African farm households use less capital-intensive technologies and smaller scales of production, informal agricultural coping methods that help households survive shocks are proving to be completely ineffective Collier, Conway, et Venables, (2018), Climate Change and Africa. The main problem is that the small-scale lot can be considered to obtain an adapter and use some irrigation technologies in Mali. The development of the irrigated System to support inclusive agricultural growth and vegetable seeds sector is a business case and economic sustainability at the farm level. It appears more important to support investments in innovative equipment by improving the practice of agriculture. The overall objective of this research is to assess the needs of vegetable seed producers in technical irrigation systems in Mali to support an irrigation decision that farmers and irrigation providers can use.

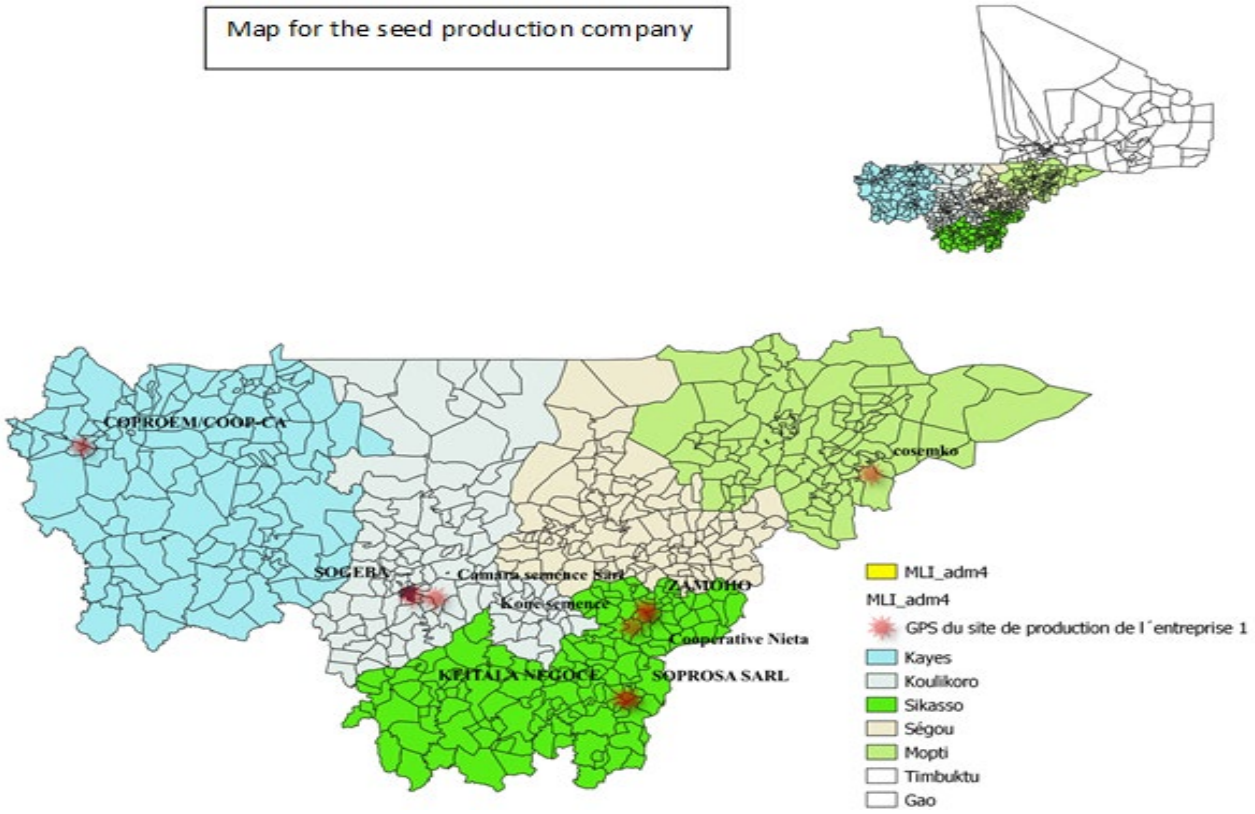

Figure 1. Map of Area Study of Vegetable Seed Production Companies

Materials and Methods

Study Area and Sampling

These studies were conducted in the regions of Kayes, Koulikoro, and Segou. These regions are favorable for vegetable seed production due to climatic conditions and the availability of agricultural labor and are in Mali. The conditions of the roads, the infrastructure, the share of the local vegetable market, and the prices in relation to the national level have enabled these areas to access the market system in their region.

The sample of 10 companies specialized in irrigation systems initially planned to give a non-exhaustive overview. Finally, these 9 companies have been surveyed. Have the interventions contributed to strengthening the capacity of the target farmer group to help themselves to be able to take charge of their garden. The selection of companies had been made on a reasoned choice while ensuring that each company has the same chance of being selected according to a normal distribution of 50% likely to obtain a favorable response from the sample of our survey of irrigation system distribution companies. Focus groups were conducted in the selected regions during the month of In May 2021. The targets were mainly seed companies. The figures 1 show the area study of vegetable seed production. It is a cross-sectional survey whose targets were pre-selected and informed before the day of the interview. The interview was conducted in the local language, the questionnaire used was digitized and saved in the KoBo Toolbox platform and deployed on smartphones for data collection.

Data Processing to Analysis

The collected information was first extracted from the KoBo Toolbox Kobo and then subjected to cleaning. Simple descriptive analysis had been in the first instance then the analysts patronized that allowed to map the seed companies of Mali. The STATA data analysis software facilitated the handling of the database in an appropriate manner. When the frequency distribution summarizes the observations for discrete numerical values, we can take the average of these values.

Different concepts have been used in different contexts to descriptive Research Design the data gathered from the literature in an interpretable model often in the form of frequency analysis Yang et Tate, (2012). Thus, we refer to the mathematical arithmetic model to measure the central tendency, the frequency. For a statistical series whose values are given by:

$$x_1, x_2, \ldots, x_n \quad (1)$$

and the frequency by $f_1, f_2, \ldots, f_n$, the average is given by:

$$\underline{x} = f_1 x_{1+f_2 x_2} + \ldots + f_n x_n . \quad (2)$$

Knowing that $f_i = \frac{n_i}{n}$, we see that the average calculated from the frequencies can be seen as a weighted arithmetic mean:

$$\underline{x} = \sum_{i=1}^{n} . f_{1x_1} = \sum_{i=1}^{n} . \frac{ni}{n} x_i = \frac{1}{n} \sum_{i=1}^{n} . n_i x_i = \frac{n_1 x_1 + n_2 x_{2+} \ldots + n_n x_n}{n} = \frac{n_1}{n} x_1 + \frac{n_2}{n} x_2 + \text{---} + \frac{n_n}{n} x_n \quad (3)$$

$$\underline{x} = f_1 x_{1+f_2 x_2} + \ldots + f_n x_n . \quad (4)$$

The final production of a descriptive analysis is considered the actual state of the research field. It helps to reduce and simplify a large volume of data to describe a population of studies accurately Yang et Tate, (2012). So, the standard deviation is the square root of the variance is an indicator of dispersion i.e.,

$$\sigma = \sqrt{V} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \underline{x})^2 = \frac{1}{n}\sum_{i=1}^{n} x_i^2 - \underline{x}^2 . \quad (5)$$

The standard deviation is homogeneous with the measured variable, that if by a change of unit, all the values are multiplied by a coefficient $\alpha > 0$, the standard deviation will be multiplied by the same coefficient. On the other hand, the standard deviation is invariant by additive shift; if we add a constant to all the values recorded, that does not change the standard deviation. Thus, the main variables used in the descriptive statistics are to improve the data collection quality.

Results

There are 9 companies that participated in providing answers during the data collection with the Masters student research. All of them have been registered in the trade register for some time. Among the respondents, 89% were men and 11% were women, all of them working in seed companies and had an average work experience of 8 years in the field and a dispersion of 2.86% of experience difference between people. It was found that the companies installed in the country have the same type of seed production. Among these, 44.4% of service is offered by local companies (only offices in 1 country) and 11.1% of other companies are regional (at least offices in 2 African countries), 33.3% are organized in farmers' cooperatives, and 11.1% of individual seed producers. However, these enterprises have an average of 4.67 years of registration and all respondents have an average of 4.22 years of work experience in their respective enterprises (Table 1).

Table 1. General Information of the Companies

Variables	N	Mean	Std. Deviation
Year of establishment of your company	9	8.22	3.70
Year of the formal registration of your company	9	4.67	2.45
Number of years of experience (working) in the company	9	4.22	2.86
Gender of respondent/Female	9	0.11	0.33
Type of seed companies' producer			
Local companies (offices in only 1 country)	9	0.44	0.53
Farmers' cooperative	9	0.33	0.50
Individual seed producer	9	0.11	0.33
Regional companies (offices in at least 2 countries in Africa)	9	0.11	0.33

Source: authors

In general, irrigation types are the only factors that can characterize irrigation system companies. The main source of water for seed production is (river, stream, lake) is 44.4%. then 22.2% respectively groundwater (well) and rainwater only diesel pump, 11.1% manual portage using containers, 22.2% of companies do not action. The individual seed producer is more important for the cooperative because the enterprises will be the least managers of the cooperative.

The farmers who physically move water from the source to the field represent 42.9% in dry season only, 28.6% respectively in both dry and rainy season only. Maximally 500 square meter acres are exploited and for the minimum meter is 25 square and a 186 square meter mean is generally exploited. For all time the companies produce twelve (12) crops in their areas which are (okra, shallot, tomato, chili-pepper, onion, latus, squash, eggplant, cucumber, cabbage, amaranth and roselle).

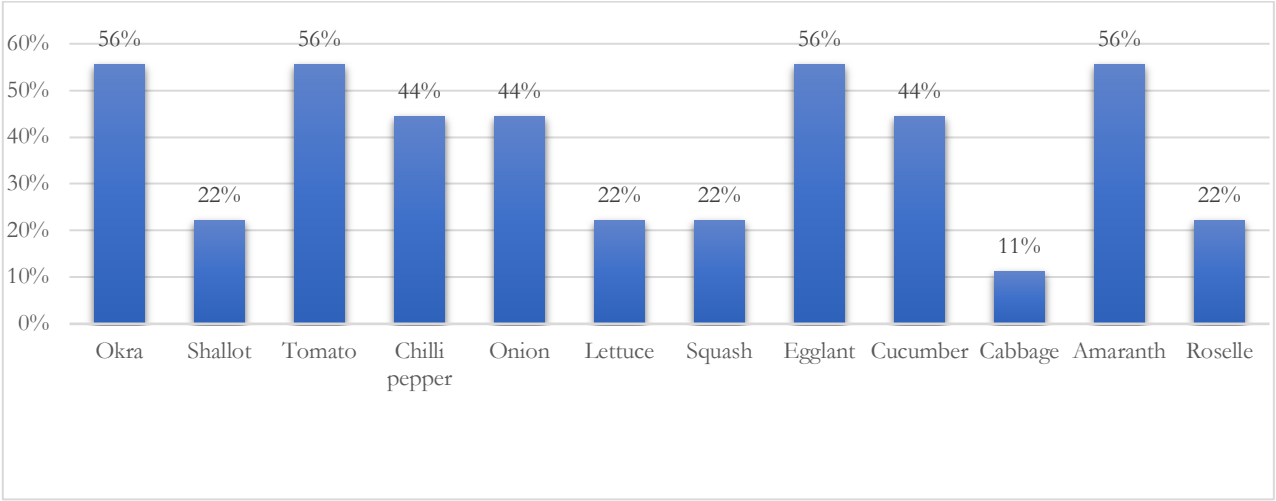

Figure 2. Adoption Crops Produced to Dry Season by Companies
Source: author

Table 2. Modality to Access or Transportation Water from Resource to Apply

Variables	N	Mean	Std. Deviation
Main source of water for your seed production			
Borehole	9	0.11	0.33
Groundwater (wells)	9	0.22	0.44
Rainfed only	9	0.22	0.44
Surface (river, stream, lake)	9	0.44	0.53
Method to move water from the source to the field			
Manual carrying using containers	9	0.11	0.33
Diesel powered pump (Motorized)	9	0.22	0.44
Solar energy powered pump	9	0.44	0.53
Rainfed only	9	0.22	0.44
Technologies to apply water in your field			
Gravity (using canals)	8	0.50	0.53
Manual (Using containers, tap, etc.)	8	0.38	0.52
Sprinkler	8	0.25	0.46

Source: authors

He believes the method has some economic benefits because 44% of seed growers said using this method is beneficial for the companies (Ets3, Ets4 Ets5 and Ets9), 33% believe a good market will be set up that farmers will surely benefit from. Irrigation has some environmental benefits to 75% of companies for the means of reducing pollution of surface water and groundwater.

The negative impacts on the environment. It through among 75% to benefits rate of set up increase profitability for a deviation of 50% standardize. Such as better seed quality is 50% benefits better seed quality Improved seed yield Improved seed availability and a large deviation between the modalities.

Table 3. Method and Characteristic Environment Economic Benefit

Variables	N	Mean	Std. Deviation
Economic benefits			
Reduce seed production costs	4	1.00	0.00
Set up increase profitability	4	0.75	0.50
Believe that the method can have some positive impacts on environmental (water use, soil conservation or climate change)	9	0.44	0.53
Methods has some environmental benefits			
Decrease erosion	1	0.25	0.50
Reduce pollution of surface water and groundwater	3	0.75	0.50
Improve water quality	1	0.25	0.50
Reduce proliferation of aquatic weeds	1	0.25	0.50
Limit eutrophication in irrigation canals and waterways	1	0.25	0.50
Improve the river flow	1	0.25	0.50
Believe that the method can have some negative impacts on environmental			
Increased erosion	6	0.67	0.52
Use a lot water	1	0.14	0.38
Proliferation of aquatic weeds	2	0.29	0.49
Believe that the method has benefits such as better seed quality			
Better seed quality	2	0.50	0.58
Improved seed yield	2	0.50	0.58
Improved seed availability	2	0.50	0.58
Reduce labor and increase plot size	1	0.25	0.50

Source: authors

About the knowledge constraints and attitude related to irrigation system company's practices. The survey data show that most of the enterprises, about 17%, don't know or have never heard the gravity irrigation, 44.4% use this equipment to irrigate in their areas. Among the companies, more than 66.7% don't use the gravity system because it is not adapted to the production season they need. Thus, 44.4% think there are other methods to move the water that would be too expensive. It is globally registered that more than 77.8% of companies have some equipment, financial resources constraints must move water from the source to the plant, 88.9% constraints to apply water to the plants Lack of information and training.

Table 4. Constraint to Move the Water

Variables	N	Mean	Std. Deviation
Wiling to adopt a gravity irrigation	7	1.00	0.00
Willing to adopt drip irrigation?	9	1.00	0.00
Willing to adopt sprinkler irrigation?	7	0.71	0.49
knowledge or have ever heard about drip irrigation	7	1.00	0.00
Constraints to move water from the source to plant	8	1.00	0.00
Will be too expensive	6	1.00	0.00
Lack of equipment	6	0.75	0.46
Equipment not available locally	1	0.13	0.35
Lack of financial resources	8	1.00	0.00
Lack of training on methods information	3	0.38	0.52

Source: authors

The Consent to adopt the irrigation system are some constraints to move water from the source to the plant. 67% Lack of equipment or not available locally, the companies need a financial resource is reach around 89% of data.

Training on water application methods, (Table 5) see the capacity building with public, private, local NGO on the popularization of the use and interest of the new technology whose last training was received at least 6 years ago. Thus, 44.4% of companies have received one on irrigation methods (methods of applying water in the field). More than 56.6% of the training methods were devoted to manual porting and irrigation systems (gravity, drip and sprinkler).

Table 5. Training on Irrigation Methods (Water Application Methods in the Field)

Variables	N	Mean	Std. Deviation
Received a training on irrigation methods	9	0.44	0.53
On what method(s) were you trained	3	1.00	0.00
Manual carrying using containers	1	0.33	0.58
Gravity - Using canals	3	1	0.00
Motorized - Diesel powered pump	2	0.67	0.58
Motorized - Electricity powered pump	2	0.67	0.58
Motorized - Solar energy powered pump	2	0.67	0.58
Who provided the training?	4	1	0.00
Public/Private extension services	1	0.25	0.50
NGO	1	0.25	0.50

Source: author

Table 6. Mapping to of the Mean of Company's Wiliness

Description	Compagnies								
	1	2	3	4	5	6	7	8	9
Knowledge or have you ever heard about gravity irrigation	■			■	■	■	■	■	
Knowledge to use gravity irrigation	■			■	■	■	■		■
Willing to adopt gravity irrigation				■	■	■	■	■	
Willing to adopt a drip irrigation									
Willing to adopt sprinkler irrigation	■		■		■	■		■	■

Source: author

The recent mapping of the current irrigation systems of seed production companies in Mali showing 56% of companies use in dry season and rainy season. The Constraints techniques to apply water to the plants are complex, require high knowledge, skills and financial investments. 56% of companies lack equipment, 44% for companies lack financial resources. It is more beneficial for the companies to use an irrigation method to reduce seed production costs, is cheap to realize or set-up Reduce seed production costs, reduce seed production costs. There are three companies involved and have economic benefits to use the irrigation system (figure 2) showed the detail.

Technical capacity in vegetable seed production and marketing. Before determining the benefit for individual farms in Mali, it is necessary to ask for the cost of the production. Their data assessment showed that over 83.3% don't use a solar powered pump because it is expensive, and the farmers have less resources to access these kinds of methods. So, 16.7% don't use the solar powered motorized pump, because they cannot afford it. But yet farmers are ready to embrace

solar power as the project will offer them around 77.8% of which seed companies already agree that farmers will join. However, 22.2% of companies have not given it, because he Will be too expensive.

The action to move water from the source to the field, to apply water in the field is 25.5% sprinkler and 37.5% of manual using containers tap respectively gravity using canal. With the application of the irrigation method is around 95% of the plants.

Discussion

According to the criteria of the type of irrigation network, we came to know that small farms are more efficient than large ones. There are few compagnies represented in Mali so that the participated in providing answers during the data collection are difficulty. Concerning the access to the resource, drilling is the main source of water to produce seeds. It is very important for the enterprises because there is a precision with a standard deviation of 0.33 close to zero. And the modality of access/transport to move water from the source to the field is practiced at an average of 0.11% of companies transport manually using containers to water the beds. This practice is relatively low within the seed companies and is close to zero. However, it is necessary to have the modality of access and transport of water from the source to the field, 44.4% use the pump powered by solar energy and standard deviation of 0.53 dispersion. Thus, about 83% of the companies already know the technology of the irrigation system but it is very expensive for them, so they prefer to use solar powered pumps. But if necessary to move water from the source to the field, the companies apply water in their field, 50% gravity (using canals), 38% for the manual (Using containers, tap, etc.) and only 25% use the sprinkler.

As per Tangara B. et al (2013), the most important crops under small-scale irrigation in the region of Koulikoro are onion (11.4%), tomato (10.9%), maize (10.4%) and rice (10%). In the Mopti region, rice and shallot are mainly cultivated. We have found that over 74% of the companies know the modern irrigation system and prove that they are more efficient than the traditional system and the cultures adopted to the different cultures. and all companies use about 100% gravity irrigation systems, 13 varieties of seed are cultivated and popularized by seed producers.

Ours studies with twelve (12) crops, we have showed that 64% of companies use the gravity to irrigate their areas, all company approximal 100% are they willing to adopt drip irrigation, 56.6% are willing to adopt sprinkler irrigation and 11.1% of companies have not used drip irrigation because it will be too expensive for them, so that 44.4% of the companies received training on irrigation methods (water application methods in the field).

Brouwer et al. (1988), in their training manual 5 explained that in general, the techniques of sprinkler and drip irrigation methods are more complex than those of surface irrigation. The choice of an irrigation method depends on the irrigation traditions in the region or country and the introduction of a new irrigation method can bring unexpected difficulties. We actually had the same point of view as Brouwer et al. (1988) during our analyzes. The choice of an irrigation method depends on the operator obtaining the equipment. The most preferred irrigation system by farmers is the sprinkler (26%), then the drip irrigation system (24%) for vegetable production. For cereal production such as rice and wheat farmers prefer motor pumps. Also 75% of producers said they had no difficulty to adopt drip irrigation, 78% for sprinkling needs for training (3%).

our study are results to need the farmers on seed companies to planning and to put an application for irrigation system access in Mali to choose the method to benefit on their areas to irrigate. Around 83% know or already heard about gravity irrigation using the Gravity canals. 56.6% of companies have constraints to move water from the source to the plant and the preference to use Irrigation method of the company's supplier knowledge.

Bertrand, (2011) found that the water savings achieved by farmers adopting new irrigation

techniques can lower the price of water charged to farmers or even lower the costs of exploiting this resource. For Kane et al. (2018), the irrigation system is credited with good technical efficiency. We had the conclusions of the Committee on World Food Security (2013) which shows that surface irrigation largely dominates the irrigation techniques used in Mali; it includes the mixed or Californian system, currently being tested over an area of the Agricultural Competitiveness and Diversification Program (PCDA). Pressure irrigation by sprinkling and drip irrigation is still very rarely practiced. Our analyzes confirm that 89% of companies want to adopt modern drip irrigation technologies and 56% want to combine the sprinkler system by reducing the cost of seed production.

Since 89% of the companies are not willing to adopt gravity irrigation among their farmers because it is not needed but it would be too expensive. Despite this the companies (1) would like to put 5,000,000 FCFA. Drip irrigation is known by the seed companies and more than 88.9% of them use this irrigation system. Only 11.1% have heard about this technology but have not used it because it is too expensive for them. All the companies in the market are ready to adopt drip irrigation in their fields.

In the end, about 78% of the seed companies that have already heard about it and are familiar with sprinkler irrigation. On the other hand, 22% do not use sprinkler irrigation because it would be too expensive. According to the opinion of the companies (8), the technology would be too expensive to have another method to move the water that would not be adapted to their field and that would increase the weeds.

Thus, the Economic benefits of an irrigation method are the belief that the method has some positive impacts on the environment (water use, soil conservation or climate change), so that without the environmental benefits are not negligible at least 44% (decrease erosion, reduce pollution of surface water and groundwater) and a large deviation of 53% between the modalities. Reduce pollution of surface water and groundwater, limit the irrigation canals and downstream waterways Improve, the river flow, surface water and groundwater reduce proliferation of aquatic weeds and pollution. Around 83% know or already heard about gravity irrigation using the Gravity canals. 56.6% of companies have constraints to move water from the source to the plant and the preference to use Irrigation method of the company's supplier knowledge.

Conclusion

Although the sample was not very representative in terms of national coverage, this study did show the economic social profiles of companies in the sector of seed production and the use of water sources and their applications on farms.

Overall, it is known that 55.6% have they ever heard about gravity irrigation and 64% use this material to irrigate in our areas. However, only 66.7% don't use it. However, in the current practice 88.9% of companies know drip irrigation and have ever heard of this method. only 11.1% have not yet used drip irrigation because it is too expensive for them. Almost 78% of companies are knowledgeable and have ever heard about sprinkler irrigation and 56.6% are willing to adopt sprinkler irrigation but it is not less to adopt.

However, 77.8% of seed companies interviewed have equipment and financial resource constraints to transport water from source to plant, 88.9% have constraints to apply water to the plant. For the lack of information and training, 44.4% of the company's received training on irrigation methods, 56.6% was dedicated to manual carrying and irrigation systems.

Globally registered to 77,8% of companies are some constraints of equipment, financial resources to move water from the source to the plant, 88.9% constraints to apply water to the plants Lack of information and training. 44.4% of the company's received training on irrigation methods, 56.6% too was dedicated to manual carrying and irrigation systems. It is necessary to adopt an application to facilitate the implementation at the local level among farmers

and promote solar systems that are adopted for irrigation.

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Conflict of interests

No conflict of interest.

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