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Benefits and constraints in the adoption of pressurized irrigation systems by the farmers in Jhalawar district of Rajasthan

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Abstract
The main focus of the study was to identify the benefits and constraints faced by the farmers in adoption of pressurized irrigation systems. Initially, benefits and constraints faced by the farmers were identified though pilot study. The intensity of the identified benefits and constraints in the actual field situation was measured to prove their validity and to find out the extent to which they were perceived by farmers as impediments to adoption of pressurized irrigation systems. Proportionate number of pressurized irrigation systems users from each selected village was selected randomly. Thus, total sample size was 380. Data was collected by a pre-tested structured interview schedule through personal interview method. The quantification of data was done by first ranking the benefits and constraints based on the responses obtained from the respondents and then calculating the Rank Based Quotient. Benefits related findings of the study indicated that save water, reduce labour costs, reduce crop failure, enhance fertilizer use efficiency, improves quality of produce etc. top most important benefits perceived by the respondents. Constraints related findings of the study indicated that high rate of interest on sanctioned loan, unsuitable in water is highly saline which causes chocking of emitters, problem of blocking the drippers due to salt or other impurities in the water, inability to minimize temperature of atmosphere, Interrupt supply of electricity for irrigating fields, high temperature reduces the durability of pressurized irrigation systems, problem of leakage of water in the pipe, monopoly of few companies who supply the pressurized irrigation sets for irrigation, procedure for getting loan from bank / societies is complicated were emerged as important constraints faced by the farmers.

Keywords: Pressurized irrigation systems, benefits, constraints, farmer

Introduction

Water is the most precious natural source, vitally important for agricultural development and day-to-day living of human beings. Intensive agriculture and over growing population are depleting the already available scarce resource of the 'Water'. This is challenging situation and the need of hour is to conserve 'water' and ensure its' efficient use because 'water' is our life and future of the nation. (Yadav, 2015) [14]. Water scarcity is currently a global issue and it severely affects the arid and semi-arid regions and countries in the world. Specifically, it will threaten the rural livelihoods dependent on rainfed agriculture and overall food security in the countries (Singh *et al* 2018; Gosling & Arnell 2016) [12, 3].

The pressurized irrigation methods, in which water is carried through a pipe system to a point near the roots where it is consumed (Nima Nejadrezaei *et al.,* 2017) [8]. This is in contrast to surface irrigation methods, in which water must travel over the soil surface for rather long distance before it reaches the point where it is expected to infiltrate and consumed (Keller and Bliesner, 1990) [6]. Adoption of sprinkler and drip irrigation system enables 28 to 56 per cent economy in the quantity of water used for irrigation, which in turn enables to bring 25 to 40 per cent additional area under irrigation, Moreover, it reduces the soil erosion, facilitates the tilling operations, increases the efficiency of fertilizers, reduces the damage through pests and consequently, enhances the crop production by 12 to 31 per cent depending upon the crop.

Various institutions and agencies have made their efforts to popularize the pressurized irrigation systems for solving the problems of water scarcity. Despite these efforts, the farmers either did not adopt pressurized irrigation systems on their farms or the installed pressurized irrigation systems were out of order on account of several difficulties experienced by them. Rajasthan is such a state where water is limiting resource, rains are uneven, drought is a recurring factor, topography is undulating. Under such situation, it is the need of the hour to adopt pressurized irrigation systems. But still the farmers are clanged to age-old pattern of irrigation, which causes huge loss of water It is therefore, desirable that conducted a study entitled "Benefits and Constraints in the Adoption of Pressurized Irrigation Systems by the Farmers in Jhalawar District of Rajasthan" was conducted. In this background the present study was undertaken with the following objective: Benefits and Constraints in the Adoption of Pressurized Irrigation Systems by the Farmers in the research area.

Materials and Methods

The study was conducted in Jhalawar district of Rajasthan India in the year 2021-2022 to analyse benefits and constraints in adoption of pressurized irrigation systems by the farmers in Jhalawar district of Rajasthan. Multi-stage sampling technique was used in the present study. In first stage, Jhalawar district was selected purposively as having 6975 numbers of micro irrigation sets as well as area under micro irrigation system is 9730 ha. This district comprises of eight blocks *viz.*, Aklera, Bakani, Bhawani Mandi, Dug, Jhalarapatan, Khanpur, Manoharthana, and Pirawa. Out of these, Jhalrapatan block was selected purposively as having highest numbers of micro irrigation sets (1109) as well as highest area (1614 ha.) under micro irrigation systems. Beenda, Borda, Donda, Jagannathpuri, Jhumki, Manda, Nayapura, Titarwasa, Shyampura, Titri Villages was randomly selected from Jhalrapatan block of Jhalawar district. Total 10 villages from the Jhalrapatan block were selected because as having 436 numbers of micro irrigation sets as well as area under micro irrigation system is 617 ha. In second stage, Proportionate number of pressurized irrigation systems users from each selected village was selected randomly. Thus, total sample size was 380. The data was collected by a pre-tested structured interview schedule through personal interview method.

The major benefits and constraints were first identified by a pilot study. Based on the pilot study, in all major benefits and constraints was identified. The intensity of these identified benefits and constraints in the actual field situation was measured to prove their validity and to find out the extent to which they were perceived by farmers as benefits and constraints in pressurized irrigation systems. Farmers was also asked to rank the benefits and constraints they perceive as limiting pressurized irrigation systems in order of preference. The data thus collected were tabulated and statistically analyzed to interpret the results. MS Excel 2019 was used to calculate the RBQ by the formula as given below in equation below low the value of RBQ represents less severity of problem, whereas, higher the value of RBQ showed high severity of problem. The quantification of data was done by first ranking the benefits and constraints based on the responses obtained from the respondents and then calculating the Rank Based Quotient (RBQ) (Sabarathnam, 1988) [8], which is as follows:

$$RBQ = \frac{\sum f_i (n+1-i) \times 100}{N \times n}$$

Wherein,

fi = number of farmers reporting a particular benefits and constraints under ith rank

N = number of farmers

n = number of benefits and constraints identified

i = Concerned ranks,

Results and Discussion

Benefits in adoption of pressurized irrigation systems

The benefits related pressurized irrigation systems have been analyzed and presented in the Table 1 along with their Rank Based Quotient (RBQ). Most important perceived benefit based on RBQ value (89.45%) was useful in saving water (I). Supporting these results Dagar *et al*. (2021) [2] found results the net utilization of irrigation water in drip system is 90% and through sprinkler system, it is 82%. Likewise, Shrivastava and Chauhan (2019) [11] revealed that water use efficiency was highest in drip irrigation, followed by micro tube irrigation, micro sprinkler irrigation and surface irrigation. Percentage of water savings were 61.44, 59.28 and 36.8 per cent for micro tube, drip and micro sprinkler methods respectively. Further Jayakumar *et al.* (2015) [4] obsereved that reduce the total water required for irrigation is to adopt micro irrigation. This can also be observed that a pressurized irrigation system had a control over water, which ultimately ended in saving the water. The second most important perceived benefit RBQ value (87.12%) was reduce labour costs (II). Supporting these results Planning commission report (2014) [9] revealed that by adopting micro irrigation systems significantly reduced the farm labour requirements by over a quarter (28.00%), particularly during the application of irrigation and weeding. Since this PIS was an automated controllable one, therefore it required very few numbers of labour for maintenance of PIS, hence the adoption of PIS had reduced the labour costs. The third most important perceived benefit (RBQ value, 83.97%) was reduce crop failure (III). Pressurized irrigation systems reduced the crop failure by ensuring the sustainable amount of water to each crop.

The fourth important perceived benefit as per RBQ value (79.56%) was enhance fertilizer use efficiency (IV). In PIS, it was possible to mix the fertilizer along with irrigation as fertigation, therefore this fertigation had effectively reduced the use of fertilizers consumption. The fifth important perceived benefit (RBQ=75.37%) was improve the quality of produce (V), since the crop received sustainable water and affirmative fertigation, the quality of product obtained from the cultivation had improved a lot. The sixth important perceived benefit (RBQ=71.80%) was reduce disease incidence (VI). Stagnation of water creates a suitable environment for the pathogens to grow and reproduce, PIS had cut down the stagnation of water and ensured there was less incidence of diseases. Benefits with RBQ values 69.00%, 65.55%, 61.20%, 59.72%, 54.13%, and 48.19% were higher yield per unit area (VII), save energy (VIII), reduce weed growth (IX), uniform distribution of water in the field (X), reduce soil erosion (XI) and convenient irrigation timing (XII) respectively.

This PIS, not only helped the farmer to produce quality produces with less incidence of diseases and pest, it also increased the yield of production by saving the power consumption, allowing water to be distributed evenly to all crops. It also reduced the weed growth and soil erosion by supply water directly to the root zone. Since, the timing of irrigation depends mainly on the availability of water, therefore availability water was not connected with pressurized irrigation system, it was connected with source of irrigation, so this benefit was least important according to the farmers. There was other seven benefits questioned in the interview schedule which became very less important benefits according to the farmers, hence those seven benefits were neglected from the study.

Table 1: Distribution of respondents according to the rank provide for benefits in adoption of pressurized irrigation systems

(n = 380)

Statements	RBQ (%)	Rank
Save water	89.45	I
Reduce labour costs	87.12	II
Reduces crop failure	83.97	III
Enhance fertilizer use efficiency	79.56	IV
Improves quality of produce	75.37	V
Reduces disease incidence	71.80	VI
Higher yield per unit area	69.00	VII
Save energy	65.55	VIII
Reduce weed growth	61.20	IX
Uniform distribution of water in the field	59.72	X
Reduce soil erosion	54.13	XI
Convenient irrigation timing	48.19	XII

Constraints in adoption of pressurized irrigation systems

Constraint implies forcible restrictions and confinement of action. In this research study to identify the constraints that hinders the adoption of pressurized irrigation systems. The constraints in adoption of pressurized irrigation systems by the respondents were categorized into five major categories namely technical, financial, infrastructural, educational and climatic and geographical constraints were discussed below.

Technical constraints

The technical constraints in agricultural production as perceived by respondent famers depicted in Table 2 along with their RBQ values. It was clear that the farmers had provided first rank to the technical problem **"**Problem of blocking the drippers due to salt or other impurities in the water" with RBQ value as 78.30 per cent. Supporting these results Verma and Sharma (2017) [13] reported that most constraints like 'clogging of drippers by suspended materials' was perceived by 88.46 per cent farmers. Likewise, Madhava and Surendran (2016) [7] reported that clogging of drippers were the major constraints in adoption of drip irrigation system. The other constraints like problem of leakage of water in the pipe (75.00%), non-availability of spare parts at village level (72.10%), high technical skill is required in operation and maintenance of pressurized irrigation systems (71.00%), lack of organizing regular trainings on operation, maintenance, repairing pressurized irrigation sets (68.50), lack of technical know-how about maintenance and repairing of pressurized irrigation sets (65.00), regular service is not available from installing agency after sale (62.30), and uneven distribution of water due to insufficient pressure of water (60.80%) occupied the second, third, fourth, fifth, sixth, seventh and eight rank according to the RBQ values.

'Problem of blocking the drippers due to salt or other impurities in the water' has been regarded as the most important technical constraint in adoption of pressurized irrigation systems. This might be due to the reason that slime, algae, sand and other organic or inorganic materials presence in the water. Similarly, the constraints like 'problem of leakage of water in the pipe' 'uneven distribution of water due to insufficient pressure of water' might be due to the reason that the pipe and laterals are very soft and manufactured by of low-quality plastic or recycled materials, hence may be damaged by rats and squirrels and uneven distribution of water. The problem of 'non-availability of spare parts at village level' might have been faced by the farmers due to the fact that the spare parts required for repair and maintenance of system were not available at village level due to high cost and could not be purchased by the farmers frequently, so generally the village shopkeepers did not prefer to keep these spare parts for sale at their shops. The other problem 'high technical skill is required in operation and maintenance of pressurized irrigation systems' for effective functioning of pressurized irrigation systems was observed. This might be due to facts that mostly farmers are technically not sounder so that they could not easily operate and maintain the function of pressurized irrigation sets. This needs a proper care and control of rats and squirrels and use pressure regulator. Another constraint 'regular service is not available from installing agency after sale', 'lack of technical know-how about maintenance and repairing of pressurized irrigation sets' and 'Lack of organizing regular trainings on operation, maintenance, repairing of pressurized irrigation sets' has also hindered the adoption of pressurized irrigation systems. Besides technical advancements, proper and timely services were inescapably needed to augment the adoption of pressurized irrigation systems.

Table 2: Distribution of respondents according to the rank provided for technical constraints in adoption of pressurized irrigation systems

(n = 380)

Technical constraints	RBQ (%)	Rank
Problem of blocking the drippers due to salt or other impurities in the water	78.30	I
Problem of leakage of water in the pipe	75.00	II
Non-availability of spare parts at village level	72.10	III
High technical skill is required in operation and maintenance of pressurized irrigation systems	71.00	IV
Lack of organizing regular trainings on operation, maintenance, repairing pressurized irrigation sets	68.50	V
Lack of technical know-how about maintenance and repairing of pressurized irrigation sets	65.00	VI
Regular service is not available from installing agency after sale	62.30	VII
Uneven distribution of water due to insufficient pressure of water	60.80	VIII

Financial constraints

Financial constrains faced by the respondent farmers in the study area are presented in Table 3. It was evident that the farmers had provided first rank to the financial problem "high rate of interest on sanctioned loan" with RBQ value as 80.12 per cent. Supporting these results Bhuriya *et al*. (2016) [1] reported that inadequate credit facilities for the farmers were the major constraints in adoption of drip irrigation system. The other constraints like procedure for getting loan from bank / societies is complicated (75.00%), lack of knowledge about government schemes for installing pressurized irrigation sets on subsidized rates (72.30%), diesel/ electrical charges are more expensive (71.00%), high initial cost of installing pressurized irrigation sets (69.20%), lack of timely availability of financial help from government through subsidies (68.75%), extra tank is needed for high pressure (66.15%), and lack of knowledge of banking facilities for loan (65.00%), spare parts of pressurized irrigation systems are costly (62.50%) occupied the second, third, fourth, fifth, sixth, seventh, eighth and ninth rank according to the RBQ values.

High rate of interest on sanctioned loan was the most felt problem for the farmers in the study area, the statement itself was a self-sympathetic one, and it denoted that rate of interest a farmer to bear for the loan he attained was a huge burden, this blocks his mentality and always made the respondents to remain in a constant depression. The best ways to get out of this problem would be the government agencies should support farmers to get subsidies, interest rate might be in considerable amount, skill enhancement trainings had to be imparted so that using those farmers could generate any entrepreneurial activities so that his/her income would increase so they could not get tensed about the rate of interest. The next problem for the farmers was procedure for getting loan from bank / societies was complicated, lack of knowledge about government schemes for installing pressurized irrigation sets on subsidized rates, and lack of knowledge of banking facilities for loan it might be because the education level of the nearly three fourth of respondents in the study area was equal or less than middle school education, hence the found difficult in handling and availing the loans by filling the requirements and meeting the necessaries and they felt difficult to gather information regarding government schemes for installing pressurized irrigation sets on subsidized rates. Diesel/ electrical charges are more expensive, this problem was related to government policies in oil prices, due to various reasons in last few months the rate of petrol and diesel has been increasing a peak, this causes not only trouble to farmers but also to every individual in the society, the other problem was high initial cost of installing pressurized irrigation sets, without having any subsidies tit would be very difficult for farmers to set up the PIS in their farms, similarly the next lacuna was lack of timely availability of financial help from government through subsidies, the reach of subsides to the needed farmers at the needed time was essential to meet the sustainability in agricultural production. The last one was extra tank was needed for high pressure, to purchase that extra tank many farmers felt their money form the pocket was wasted.

Table 3: Distribution of respondents according to the rank provided for financial constraints in adoption of pressurized irrigation systems

(n = 380)

Financial constraints	RBQ (%)	Rank
High rate of interest on sanctioned loan	80.12	I
Procedure for getting loan from bank / societies is complicated	75.00	II
Lack of knowledge about government schemes for installing pressurized irrigation sets on subsidized rates	72.30	III
Diesel/ electrical charges are more expensive	71.00	IV
High initial cost of installing pressurized irrigation sets	69.20	V
Lack of timely availability of financial help from government through subsidies	68.75	VI
Extra tank is needed for high pressure	66.15	VII
Lack of knowledge of banking facilities for loan	65.00	VIII
Spare parts of pressurized irrigation systems are costly	62.50	IX

Infrastructural constraints

The infrastructural constraints in agricultural production as perceived by respondent famers depicted in Table 4 along with their RBQ values. It was understood that the farmers had provided first rank to the infrastructural problem **"**Interrupt supply of electricity for irrigating fields" with RBQ value as 76.20 per cent. Supporting these results Verma and Sharma (2017) [13] reported that most constraints like 'insufficient supply of electricity for irrigating fields' was (Infrastructural constraint) expressed by 81.20 per cent farmers**.** The other constraints like monopoly of few companies who supply the pressurized irrigation sets for irrigation (75.00%), generally, timely spare parts are not available (72.30%), lower quality of pipe and micro-tubes (71.00%), technical staff, working in the field is not available (69.50%), inadequate distribution network in rural areas (68.00%), and service by the companies are poor after sale (66.45%) occupied the second, third, fourth, fifth, sixth, and seventh rank according to the RBQ values.

Insufficient supply of electricity for irrigating fields was the major infrastructural constraint felt by the farmers. Government has to take steps to disseminate the electricity to all areas with proper management strategies, this would be the solution for this problem. The next problem was monopoly of few companies who supply the pressurized irrigation sets for irrigation, there were no choices for farmers to choose the PIS sets since only one or two giant companies were there to provide PIS sets in the study area, the next problem was the continuation of the previous problem 'timely spare parts are not available', since the monopoly exists demand was huge compared to supply of the products, hence it takes much more to get the spare parts. All other problems were also related to the monopoly of PIS companies they were lower quality of pipe and micro-tubes, technical staff, working in the field is not available inadequate distribution network in rural areas, and service by the companies are poor after sale.

Table 4: Distribution of respondents according to the rank provided for infrastructural constraints in adoption of pressurized irrigation systems

(n = 380)

Infrastructural constraints	RBQ (%)	Rank
Interrupt supply of electricity for irrigating fields	76.20	I
Monopoly of few companies who supply the pressurized irrigation sets for irrigation	75.00	II
Generally, timely spare parts are not available	72.30	III
Lower quality of pipe and micro-tubes	71.00	IV
Technical staff, working in the field is not available	69.50	V
Inadequate distribution network in rural areas	68.00	VI
Service by the companies are poor after sale	66.45	VII

Educational constraints

Educational constrains faced by the respondent farmers in the study area are presented in Table 4. It is evident from the table that the farmers had provided first rank to the educational problem "lack of knowledge about operation of pressurized irrigation systems" with RBQ value as 71.20 per cent. Supporting these results Karthikeyan and Naidu (2017) [5] found that the major constraints in adoption of maintenance of drip technology were farmer facing insufficient knowledge about operation of drip irrigation system. The other constraints like lack of individual's contact with experts related pressurized irrigation systems for effective adoption (70.40%), adequate number of demonstrations were not arranged to motivate and develop skills for its adoption (69.50%), farmers training are not arranged for its installation (adoption/use) (66.50%), inadequate awareness about the advantage of pressurized irrigation systems (62.30%), lack of systematic campaign for popularizing the pressurized irrigation systems (60.70%), and untrained farmers feel difficulty in using pressurized irrigation system (58.65%) occupied the second, third, fourth, fifth, sixth, and seventh rank according to the RBQ values.

Lack of knowledge about operation of pressurized irrigation systems was the major constraint felt by the respondent sin the study area, it was already mentioned that the education level of the nearly three fourth of respondents in the study area was equal or less than middle school education, so the farmers felt struggle in understanding and applying the concepts of PIS, the next problem was lack of individual's contact with experts related pressurized irrigation systems for effective adoption, it might be because of social participation of person, majority of the respondents had low level of social participation. Adequate number of demonstrations were not arranged to motivate and develop skills for its adoption, farmers training are not arranged for its installation (adoption/use), inadequate awareness about the advantage of pressurized irrigation systems, lack of systematic campaign for popularizing the pressurized irrigation systems and untrained farmers feel difficulty in using pressurized irrigation system was the third, fourth, fifth sixth and seventh major constraints respectively felt by the farmers in the study area, since the level of education in the community was low, the trainings and demonstrations needed to be high, but here it was inadequate, so farmers were less aware about the PIS technologies.

Table 5: Distribution of respondents according to the rank provided for educational constraints in adoption of pressurized irrigation systems

(n = 380)

Educational constraints	RBQ (%)	Rank
Lack of knowledge about operation of pressurized irrigation systems	71.20	I
Lack of individual's contact with experts related pressurized irrigation systems for effective adoption	70.40	II
Adequate number of demonstrations were not arranged to motivate and develop skills for its adoption.	69.50	III
Farmers training are not arranged for its installation (adoption/use)	66.50	IV
Inadequate awareness about the advantage of pressurized irrigation systems	62.30	V
Lack of systematic campaign for popularizing the pressurized irrigation systems	60.70	VI
Untrained farmers feel difficulty in using pressurized irrigation system	58.65	VII

Climatic and geographical constraints

The constraints related climatic and geographical constraints of agriculture production have been analyzed and presented in the Table 2 along with their Rank Based Quotient (RBQ) It was evident that the farmers had provided first rank to the climatic and geographical problem "unsuitable in water is highly saline which causes chocking of emitter" with RBQ value as 80.00 per cent. Supporting these results Verma and Sharma (2017) [13] reported that most constraints like 'unsuitable in the area where water is highly saline' was (Climatic and geographical constraint) perceived by 68.80 per cent farmers in adoption of drip irrigation system. The other constraints like inability to minimize temperature of atmosphere (78.20%), high temperature reduces the durability of pressurized irrigation systems (75.60%), inability to minimize temperature of atmosphere (70.00%), and unprofitable where land is leveled and ground water available in sufficient quantity (65.30%) occupied the second, third, fourth, fifth, sixth, and seventh rank according to the RBQ values.

The major climatic and geographical constraints in adoption of pressurized irrigation systems was unsuitable in the area where water is highly saline which causes chocking of emitter, this might be due to the reason that slime, algae, sand and other organic or inorganic materials presence in the water. The next problem was inability to minimize temperature of atmosphere, this one was out of the hands of a person, and this could be sorted out only by increasing the frequency of irrigation. High temperature reduces the durability of pressurized irrigation systems was another problem, due to the high temperature the metals and polymer used in the PIS systems gets contracted, elaborated, rusted and damaged. When the nature of soil was clay, the PIS system fails due to the characteristics of that particular soil type, and finally PIS would be unprofitable where land was leveled and ground water available in sufficient quantity, PIS should be implemented in the areas where the water is scare, if there were plenty of water available there was no need for PIS, sine the method of irrigation would be different and also the soil characteristics would be different.

Table 6: Distribution of respondents according to the rank provided for climatic and geographical constraints in adoption of pressurized irrigation systems

(n = 380)

Climatic and geographical constraints	RBQ (%)	Rank
Unsuitable in water is highly saline which causes chocking of emitters	80.00	I
Inability to minimize temperature of atmosphere	78.20	II
High temperature reduces the durability of pressurized irrigation systems	75.60	III
Unsuitable for clay soil	70.00	IV
Unprofitable where land is leveled and ground water available in sufficient quantity	65.30	V

Conclusion

From the above findings it may be concluded that farmers are benefitted more by using pressurized irrigation systems compared to the traditional methods and the constraints which are identified and remained as bottleneck for the adoption of pressurized irrigation systems by the farmers. Hence efforts are needed to overcome those constraints by providing information on different information sources and motivate them to access different sources, organize field exposure visits to successful farmers, farmer extension functionaries and researchers in the field of pressurized irrigation systems to improve the farming performance through efficient and sustainable utilization of water and farm inputs.

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