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Application of Technology in an Innovative way for the Restoration of Natural Resources: Experience from a Village of Kutch District, Gujarat, India

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Abstract

Technology brings differences in insulating solutions to people's life if it is used intelligently. This paper aims to share the experience of illiterate women of one of the remote villages of semi-arid Nakhatrana Block of the Kutch District, Gujarat. The women of this drought prone area had a very tough life in the past because of the scarcity of water resources that precipitated male migration with animals to look out for pasture land for grazing or peri-urban areas for work opportunities. The continuous struggle with their survival and absence of male members in the family triggered the inner strength of the women of the community and they decided to change their destiny. They took up the challenge to conserve water and restore the natural resources through the combination of old and new technology in an innovative way. As a result the illiterate women from both Muslim and Hindu community came together, became the manager of natural resources and have leveraged their leadership potential. It also analyses the use of technology in an innovative way for reviving and restoring the water resources that has directly and indirectly influenced the livelihood and socio-economic scenario at the micro (household) level, meso (community and block) level. The paper is based on the empirical study carried out as part of the researcher's doctoral work.
Both primary and secondary data sources were explored and in-depth interview and focus group discussion was carried out to draw data from the study participants.

Keywords: Technology, innovation, natural resources, women.

Introduction

It has been observed that there is intense relation between the livelihoods of the local people and the preservation of environment such as land, water and forest for their, food, fodder, fuel, water etc. because their well-being depends upon the availability and accessibility of the resources from the immediate environment that can provide them income, health, dignity of life, quality of life. However, in present day there is continuous struggle for the poor to make their living from the natural resources due to the continuous depletion of the natural resources. Water in the semi-arid and desert is a precious resource. The problem of water scarcity, severe land degradation, lower yield, deforestation etc. in the rural areas challenges the livelihood of the people. Different factors such as population growth[1], intergenerational factor for resource exhaustion[2], industrialization[3], have been considered as reason for depletion of natural resources. Nevertheless, degradation of natural resources organised local people for collective action. Local people along with the support organizations like NGOs took different approaches like watershed development, rain harvesting, agro-farming with the introduction of technological innovation through collective groups for the preservation of environment. The main objective of the paper is to look into a collective initiative that was majorly taken up by the women from the remote rural village of Kutch District in Gujarat for restoring the ecology to bring socio-economic change and ensure sustainable livelihood in their village through the introduction of technology.

There is an argument that the relation between technology and the environment is complex and paradoxical[5]. On one hand, the introduction to the new technologies has been considered as one of the factors for the depletion of the natural resources that exert environmental stress whereas on the other hand technology may be used for effective and efficient use of resources[6] if used intelligently. This paper makes an attempt to look at the positive aspect of the application of the technology in an innovative manner for the restoration of the natural resources.

For this paper, two terms are important–technology and innovation. Technology plays a vital role in people's life. It not only matters in biological and material condition rather it helps in living socially. As per Greenberg and others[6], word technology is rooted in the crafts of making of applying tools with skill and of achieving preconceived ends. It means that application of technology is done with the outcome in the back of the mind that would be expected result of that particular intervention. The application of technology requires a base in advance in most of the cases. In any context, to bring technological change or introduce new technology, it happens upon the existing technology with the mixing of new

combination of technology[7]. In a scientific term there is an understanding that any new technology is developed on the basis of "traditional system design", which becomes the starting point of most of the initiatives[8]. For this paper, technology is understood as technical means used by the people to produce better products with the application of tools and machines to do task efficiently[9]. For the successful outcome of technological intervention, innovation comes along with it. Innovation does not mean to do something new or extraordinary. Innovation could happen with old things also by introducing added values with fresh and original ideas to do things in better ways and try out in practice[10]. The definition of Poole and Buckley's[11] view is more relevant for this paper who looked at innovation as novelty, new things being done, or old things being done in new ways. In the context of this case study, technological innovation happened and to have clarity it is important to explain about technological innovation. Technological innovation has multiple definitions in the literature. For example, Courvisanos[12] understood technological innovation as politically charged concept, whereas Gingras & Niosi[13] defined technological innovation as economic issue. They followed the Freeman[14] (ibid), who defined technological innovation as a new or improved product, process or production system that is commercially used and or produced. For this paper technological innovation has been understood as technical change that has led to increased productivity, improved goods and services and or economic growth.

Research Design

The research followed case study method. The qualitative case study approach was suitable as it facilitated exploration of a phenomenon within its context using a variety of data sources. In case study method, comprehensive study of the village is consider as a whole unit of analysis. The method helped to get exhausted data. According to Mustafa[15], through case study method, researcher get the scope to gather wider combination of data that support to understand the social processes or events or behavior of individual in the research setting . Case study is suitable as it helps to have comprehensive study of the system in a particular context and process involved in the phenomenon under study Yin[16,17] for which multiple sources for data that included observation, interviews, narrative sources, writings such as journals, dairies, reports etc[18] were used

Application of System Approach

The paper is looked through the systemic thinking lens applying the system approach. According to this framework, the rural community of Dawantpur[1], in the Kutch District, is viewed as a system with sub-systems which have multiple elements within each sub-system[19]. The sub-systems comprises of complex social, economic, natural, sub-systems which are linked to each other and influence by each other that has positive or negative consequences on the life of the people in the community who are the part of the larger system. People are considered as actors in the system who are in constant interaction with system and its sub-systems. The system is considered to be dynamic as any kind of intervention from the simplest form to complex will have an effect on the overall community system[20] and will respond to that accordingly. This case study attempted to bring out the changes that have happened within the system with the introduction of technology innovatively in order to restore the natural resources which are one of the sub-systems that has positively influenced other sub-system and brought desirable changes.

The system thinking gives emphasis to begin with the understanding of the context to capture the relationship between the sub-systems, actors and process within the system. In this the human action is understood as structured and emphasis is given on the systems that involved resources and material aspects, actor's action in bringing and maintaining change within the system and formulate rules and institutions within which further actions are guided With this intention, it become utmost important to have a prior understanding context that generated demand for intervention before we delve into the discussion on how technology brought changes in the larger system.

Natural Context: Kutch or Kutchchh region lays in Gujarat. According to 2011 census Kutch has the population of 2090313. Kutch has its own unique fragile eco-system and is surrounded by water in the south for which it is also known as "*Kutchdweep*" and desert in the north, the great and small ran of Kutch. The desert is uninhabitable that completely submerged by flood during monsoon. The area comes under semi-arid zone. The inadequate rainfall results in recurrent phenomenon of drought in every two to three years in the cycle of every five years.

Dawantpur is in the Nakhatrana *taluka* of the Kutch district. The village falls under the desert and hill prone area. It is 60km Northwest to Bhuj, bounded by Banni in North, Dhinodhar Dungar range in South and in East Bhukhi River flows South North which merge in Banni. Dawantpur has three types of layer in the land. Dinodhar mountain which is a hilly tract, below that there are fields which is called as "*kup ka Vistar*" and after that "*Vani ka Vistar*". Kup means where there is soil and sand. In soil there are three varieties- one is *chikni mitti* (clay type) where there will be no farming as it has salinity, sand type (where there is sand you can do proper harvesting), basalt and hilly track farming is not possible as trees, grass etc. grows there. In this area the major portion of the land is composed of basalt. Some areas are sandstone means those areas where water get recharge and get spread. In the entire land 2-3 area had that patch and nearby that area there are many farm lands.

Availability of drinking water was major problem in Dawantpur. There is the history that the previous village was little ahead than the area where the village is located presently. This village was settled in the present location 70 years back.

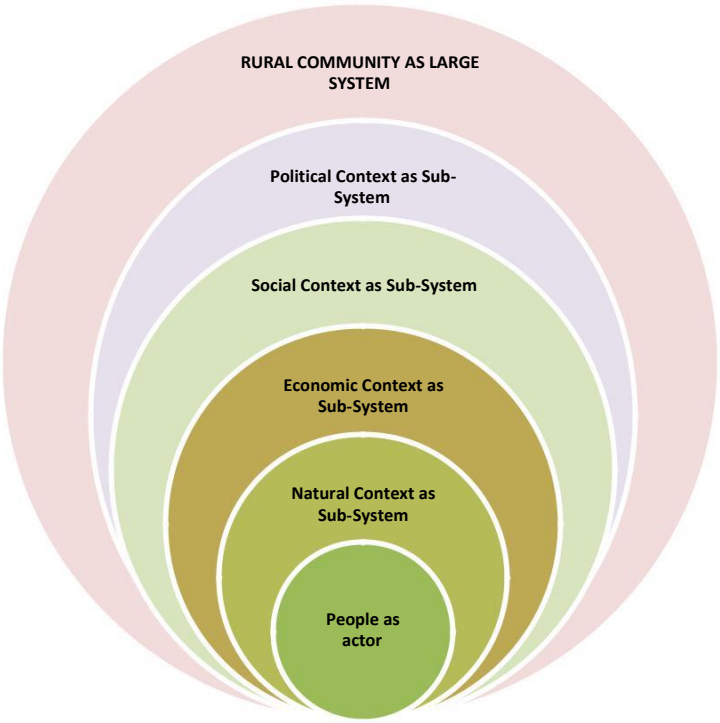

Figure-1

In the previous area there was water but later on dried up. People thought there will be no more water so they left that place and relocated their village in the present location. This fact indicated the support agency that there are certain areas where water can be recharged. For water there is a *talab* which is open but during winter and in summer the water *talab* get dry and cannot be used. There was no permanent solution. They were dependent upon tanker and pipeline.

The village has forest land which is abundant with "English babul". The forest is majorly full with thorny trees which are useful as fuel wood. For fuel wood village go in group with any of the household having their own tractor and collect together for a month. They spent whole day in the forest and bring in bunches and stock it in their courtyard that may serve them for month. As the rainfall is very less so, the chances to get wet is very less. The vegetation of the area is poor. Few of the households in the ahir community though tried for kitchen garden; they did not get success

Population and settlement: There are 118 households with the total population of 578 (298 males and 280 females). The village has major community of distinct religions, the *Ahir* Hindu, *Jadeja* (*Darbar)* and Muslim among which *Theba* (dominant community), followed by *Verar, Sameja and Saiyad*.

The settlement of the village is divided into the two sides of the main road. In one side of the road, there are 34 houses from the *Verar* community clustered together with two houses from *Saiyad* in little distant and 5 houses of *Sameja* at its adjacent.

On the other side of the road, the village settlement is majorly divided between Muslim and Hindu community. The front part of the village is the settlement of houses from the *Theba*, predominant population of the village, few houses from *Sameja* and a household of *Saiyad* and in the backside of the village was the habitant of *Ahir* community along with one *Darbar* family. The settlements were named by their caste name – *Thewawas*, *Samejawas*, *Verarwas* and *Ahirwas*. It has been observed in *Thewawas*, three to four houses were clustered together having a common courtyard and there is no boundary between them. Usually the houses of closest kin stay near to each other. On the contrary, in *Ahiwas* all the houses were bounded with boundary either with concrete structure or fenced with the branches of wild stem even if they bear any relation.

Before the earthquake, all the houses were "*kuttcha*". After the Gujrat devastating earthquake, single unit houses were provided to ninety percent of the villagers with the support from Red Cross, Sardar Awas Yojna and Panchayat and ten percent are yet under the process to get under Sardar Awas Yojna as reported by Panchayat up-sarpanch who belongs to from village.

Economic Context: Livestock rearing is the major occupation of the entire Kutch belt, which is not different in the studied village. In this village, the muslim community is the traditional pastoralist who called themselves as "*Maldar*", where "*mal*" refers to animals and "*dar*" refers to owner**.** They rear different kind of livestock like buffaloes, cow, camel, goat, and sheep**.** Livestock is a very important asset for every household in the community. Though *Ahir* households also rear livestock, for

them agriculture comes first and livestock rearing is the secondary occupation. As the region faces drought in a cyclic interval of 3-5 years, the agriculture activities remain under scepticism and that time livestock provide supports to an extent**.** Livestock is not only asset which community consider as means to encash as money by selling them during their crisis situation but also means of their livelihood. Livestock ownership is traditional among the muslim community of the village who are traditional pastoralist. *Ahir* hindu also keep livestock to have secondary livelihood source.

Presently, the village is in the transformation phase of primary occupation change i.e. from pastoralist to hard core farmer. The loss of number of livestock years after years due to drought as well as more legal prohibition and decrease in the quantity and quality of common property resources turning out pastoralist community to agriculture wage labour. Whenever drought hit the region, the people of the village failed to manage the problem of fodder and leave their animals in the cattle camp or migrate to pasture land.

In past village witnessed acute water crisis that completely slacked their earning sources in multiple ways. Firstly, village had no source of drinking water of their own for which they had to remain dependent upon tanker whose service was irregular or women had to bring water from 3 km away from their village losing their time and opportunity to go for earning for the day. Secondly, the unavailability of water forced male to migrate outside the village with their livestock near the pasture land that increased the economic burden over the illiterate women of the village. Irrigation facilities are not owned by small and marginal farmers and there was minimum or no agricultural production. As a whole the community survived on extreme adversity without water and maintained their traditional occupation of farming and animal husbandry. Availability of sufficient fodder for livestock always forced farmers to become dependent upon market to buy the required inputs at higher cost which was possible for wealthy group of farmers; rest had to think of other alternatives such as selling off their livestock, migration of male members to distant places with their livestock, or in search of work.

Social Context: The village greatest strength could be observed in its social capital. All the household of the Dawantpur village are in good relation with each other. Holding of strong social capital serves as their support system during any kind of crisis – social, economic, health etc. Support from friends, relatives etc. give them courage to fight back with worst situations.

Financial Context: In their daily life, household remains dependent upon their neighbor and relatives from whom they draw small amount credit. When the credit requirement increases for making investment into productive activities like purchase of livestock, investment for cultivation, purchase of any equipments etc. the household turns towards credit federation of the Kutch Mahila Vikash Sangathen, in which women are active members. The purpose of the credit majorly for agriculture activities, purchase of livestock, cattle feed etc. Relation with the bank is limited to few households. Community has less satisfactory relation with the bank. From community point of view, they find the process of getting loan from bank is time consuming and for which sometime have to negotiate with work opportunities.

Injecting technology for the restoration of the natural system: Water scarcity was recognised as major problem for the adverse situation of the village. The situation got exaggerated with the continuous decline in the level of the ground water that had negative affected the system (village) and the life of the actor within the system. The deterioration of the environment affected three major aspects- food, fodder and water. The dying utilization of traditional water storage structure and absence of irrigation structure made the functioning of the system weak. As women bore the brunt of ecological degradation so women decided to take the support of technical support to improve their ecology and improve their ability to do work more effectively. Because of that, the illiterate women from both Muslim and Hindu community came together, became the manager of natural resources and have leveraged their leadership potential. It also analyses the use of technology in an innovative way for reviving and restoring the water resources Along with the women, the intervention agency (KMVS and Sahejeevan) realised the need for the environmental regeneration through technological innovation. Women of the village came forward and took up the challenge to bring changes in the existing old water storage structure (old technology) and modify it with the introduction of new combination of technology with the available resources which were in the form of local knowledge and input devices. The introduction of technology happened innovatively as old things were modified in a new and better way that strengthened the natural system and revived the other sub-systems by creating socio-economic benefit. The process of technological innovation moved in systematically into different stages that is discussed below –

Technical training for women in natural resource management: Women exhibited their interest to work towards solving their problem and worked towards modifying the traditional sources of local water. They trained themselves and acquired new skills of natural resources conservation and management[21]. Technical support team Jan Vikas Ecological Cell (presently known as Sahejeevan), supported these women in their endeavour with their expertise[21]. The technical knowledge of the team, gave hope to the women by making them aware about the possibilities of the village to become a self- reliant on water due to the geo- hydrology situation of the region where the village is located. Geo-hydrology of the region shows that the region has shallow ground water, where recharging structure could turn to be highly beneficial and secondly, the possibility to set up aquifer management in the village for satisfying water need and become self- reliant[22]. The immediate visualization of the self-reliant village motivated the women get engage in the process of

technological intervention**.** Women were technically trained to understand technologies related to watershed development and water management. The imparted training developed their capacities on natural resource conservation and management and enhanced the goal to enable their local knowledge in designing and managing the environment related project. Women became the eco-worker and barefoot engineer.

Women in the process of searching for water: After the completion of the training, women and other experts at the local level were engaged in the geological survey to identify the patches of the sandstones where water recharging structure could set up. They used to spend hours after hours in the field area, collecting various rocks samples to identify appropriate sites having quality aquifers. The illiterate women took the lead in the survey along with the technical support group in the process and turn out to eco-worker and barefoot engineer. The hard work of women and other villagers paid and water was found at the depth of 90 feet. Along with the establishment of new structure, old water storage structure was also revived that became the source of irrigation for four months after the monsoon.

Setting up of water harvesting structure: With the identification of site for water availability from geological survey, new water harvesting structures were constructed and old water storage structures were revived. - the *prabasar talab*, the *debrai* and then *dakhai* dam. With these structures, the storage area for water increased. For the first time, in 2003-2004, village could develop their own drinking water source with the establishment of tube-well and well for drinking water. The restoration initiative not only gave drinking water to the villagers but also brought positive changes in the farm land that became beneficial for the farmers. The water structure recharged water and increased the water table of the farm land that improved agriculture productivity.

Insertion of Technical device for water lifting: Setting up of structure was not the end of the initiative. The major concern to lift water and bring the water in the village remained as major concern for the villagers. Then, the question came how to take water to the village, how would be the distribution system to have longer time water sustainability. If you place machine and motor over that then it will get exploited will not continue for longer time. Diesel engine was used to lift water, however sooner it turned out to be expensive and the less profitable for the community. Moreover, introducing a non-renewable source of energy goes against the ideology of the entire intervention principle that encourages natural process of reengineering the ecology then with the application of inputs like fuel that develop dependency syndrome among people. Considering the high expense and uncertain electric supply to the village that affect water supply, insertion of solar water pumping system was encouraged as alternative means for water lifting. Solar pump of 0.75 HP was installed in the village. People of the village were little skeptic about solar pumping system, however sooner the output of the system showed positive and satisfactory outcome and proved to become an admirable option with low expenditure and higher yield and solar pump indeed came as novelty.

The technical parameter of the solar hand pump as described in the report of Sahejeevan , the technical support organization,
"*The solar pumping system has 1800 Wp solar modules from Tata-BP and a 0.75 HP AC submersible pump and inverter from Grundfos. Solar panels are mounted on a manual tracking system. Submersible pump is installed in a bore well with 30 meters suction head. Water is supplied through a 4 inches PVC pipe to a water tank located 1.8 KM from the well. There is a gradient of 14 meters from the well to the tank. Total head from the pump to the tank is more than 47 meters. The installation was observed at foundations of the array, interconnections, inverter installation, fencing and piping. All parameters followed the guidelines prescribed for such an installation. The long distance of 1.8 KM is between the well is taken care by over sizing the pipe diameter. This long distance for relatively small pump is unique. Considering that before a 10 HP diesel pump was not able to do the job this site is a good model of a technical viability of solar PV pumps*"(13)[23]

New experiment with group well: The concept of group well evolved as a new technological initiative to provide irrigation facilities for the poor farmer families in the community. At the initial level, 22 families were identified who became the beneficiaries of this initiative. The initiative became more interesting when community decided to apply their traditional knowledge and used Prosopsis Julifora (grass fire) as fuel run the pump for lifting water[24]. This initiative developed positive attitude in the community especially among women and encouraged them to remain involved in the process of change with more enthusiasm.

Conservation of the developed system: There is an believe that human being has the tendency to extract maximum from the environment. Such tendency develop major concern for the conservation of the natural resources and work towards the management and operation of the system for systematic, fair and equal and distribution of water. The community based resource management become out most important in which it will be the responsible of the community to protect the resources from exploitation and take care of the equal distribution of the resources across all the group of people in the community. To make equal access to natural resources among all the groups of people of the community in a decentralized manner, village level committee was formed. Women took the lead and set rules and norms for the management of the intervention. The committee collects water tax where every household have to pay Rs 3 per person per month towards the maintenance of the system. The collected amount is used for the salary of a local physically challenged youth who has been employed to maintain the pump, for the repair of the minor faults. The arrangement has developed a sustainable system for which community ensure the ownership towards the community asset and feel responsible for its maintenance. The reliability on the system has developed

firm believe upon the technological arrangement through which water is supplied in the village and people socially accepted that and regularly pay the charges for using the service.

The entire intervention could be looked at as simple water shed programme. However the uniqueness of the programme lies in the modification and revival old technology to give a new looks with the application of solar pump water system. Secondly, usually women participation in the watershed programme is negligible, whilst in the case of this village, women took the charge and became the manager of the environment, and looked at the technical aspect, engaged themselves in scientific study of geological survey, applied their expertise to bring change for the large goal of restoring the natural system in order to improve the condition of the larger system.

Consequences of the intervention

The introduction of the technology to make one of the sub-system (natural system) active, that impaired other sub-system (economic, social), and disturbed the functioning of the larger system (village), supported in bringing positive changes in all the sub-systems and improved the condition of the larger system. The changes that has been observed with the technological intervention for bringing water in the village are as follows –

Social - Economic consequences: The village show changes in the role of the women especially among the Muslim women of the community. They have taken up the responsibility to manage and support their partner by sharing their work. Muslim women also show control over the financial aspect unlike the women from the Ahir community where men have the domination over everything. *Ahir, Siyad and darbar* community follows rigid patriarchy culture whereas *Sameja, Theba* and *Verar* gives more freedom to women. In Muslim community women have control over money, like when money comes at home they have the control over it. They not only keep money with them, they take active participation in decision-making. In Muslim, women even go to the market to purchase their every month household goods and secondly, women have relation with the shopkeeper who trusts them and gives credit because they do not know husband and she goes regular to purchase things. In one way women have become more trustworthy and dynamic in establishing social work whereas in other way they have become overburdened with too many responsibilities. In contrast to that, among *Ahir*, women do keep money and whenever require man take from them, they lack control over that. Only in social functions like marriage etc., women take decisions and spend money and go themselves to get things. They take the decision where to spend the money, what to be given to whom, women only decides. When it comes for the entire economic transaction and outside activities, women are neither consulted nor informed in prior to the decision making about the economic transaction and men take complete decision. Activities related to purchase of seeds, where to spend money for business, how much etc. are decided by men.

The workload and family burden of women reduced with the decrease in migration of the male members by seventy percent. The affiliation of women with the group has strengthened their social bondage with regular interaction which serves as strong support system. Socially the status of the women improved and encouraged them to work towards more problems once they solved the water problem of the village. The engagement developed confidence among women and increased their ability to take equal responsibility along with men.

In the economic term there is Increase of Rs 50/- (approx) per day at household level because of dairy. Moreover, the family members have the freedom to go for work without spending time in waiting for tanker to come to get water or fetching water from distant places. There is productivity enhancement in agricultural product which has increased the income. There is overall economic improvement in the village.

Leadership Development: The process brought transformation among women who became empowered to deal with their situation. The acquired knowledge encouraged women to work towards awareness building of others about ecology, to protect their available resources like wells, tanks etc.; developed women's ability to bargain, negotiate and do business with competing market for their product.

Institutional Development: Emergence of village level institutions like saving & credit groups, milk producer groups, fodder bank. These institutional arrangements could become possible due to the water availability that has supported in revamping the traditional occupation of the agriculture and animal husbandry which in turn revived the occupation and improved the economic condition. Because of the availability of the fodder, the purchase of animal increased and dairy business evolved professionally. There is an increase of rupees fifty approximately per day at household level because of dairy. The arrangement for livestock rearing was organized in which facilities such as- improved access to animal health services & sixty percent loan for purchase of animals from federation was offered, improved livestock rearing practices are encouraged, induced interest and ambition towards the animal husbandry occupation, Controlled animal diseases and increased productivity through proper treatment facilities. Similarly, more number of households getting involved into agriculture.

Development of structure: At present the village water supply from Bhukhi Dam. The village has 3 GL Cistern constructed by the organization called Sahejeevan aand 3 10,000 liter capacity tanks for respective communities in their own hamlets. However, the tanks in ahirwas and samejawas have been lying non-functioning. There is a well about 2 km away from the village. Water from the well is pumped with solar pump and collected in to the 30,000 lit GLR Cisterns and from there water is again distributed into the small tanks in each hamlet through distributional pipe line. There are two separate open concrete water tank for animals.

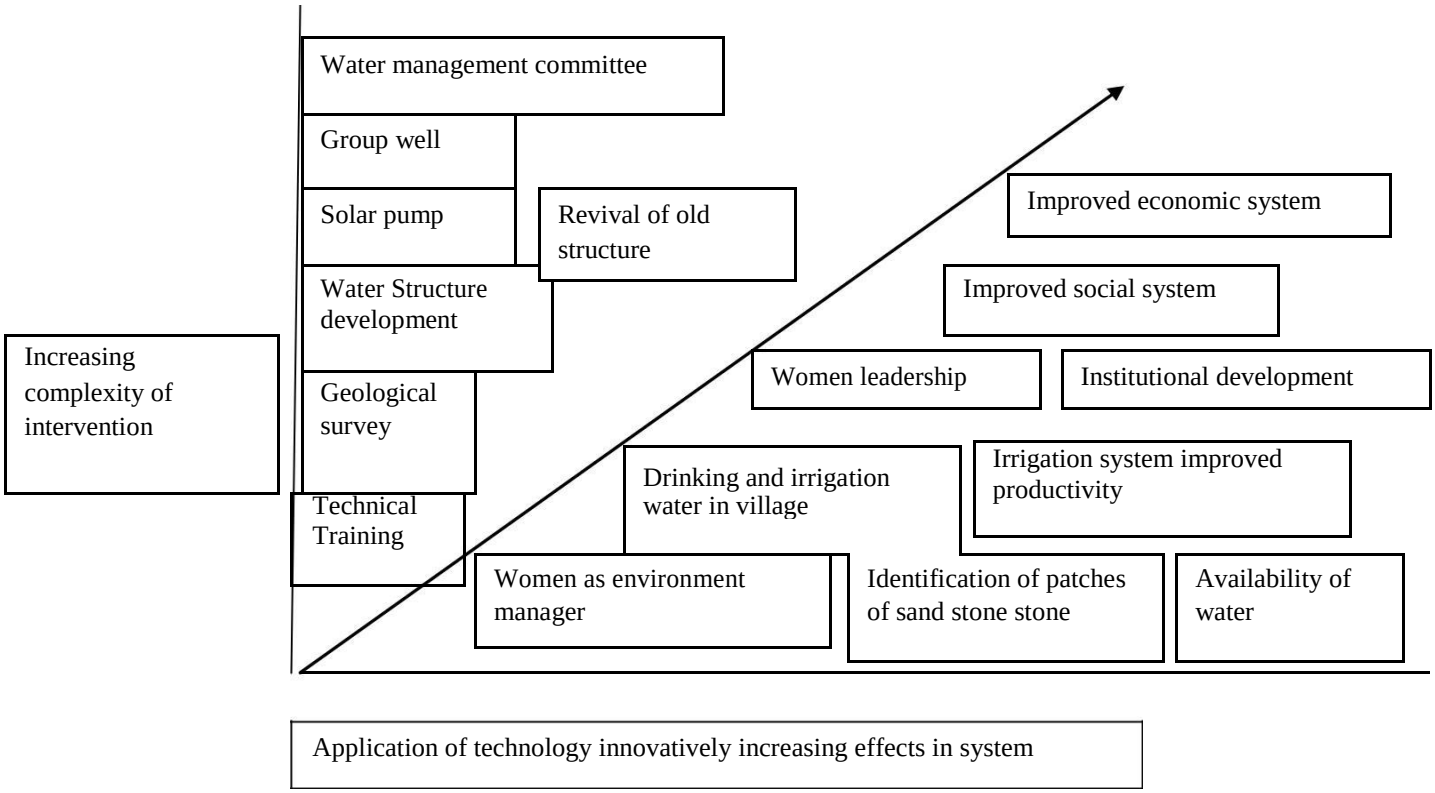

Figure-2

Thus, the technological innovation from simple to complex arrangements applied to restore the ecology has achieved success in improving the larger system.

Conclusion

This is an interesting case that reflects the intelligent application of technology in the older system to bring changes with adding some new combination for larger social system. The case study expressed that technology has the ability to improve or make modification within any parts of the system or sub-system, which can bring positive outcome if technological innovation happens properly. The uniqueness of the study remains in the constant interaction between women, environment and technology that seemed to have broadened the affects in the wider system with the increasing application of technology.

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