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LASER IRRIGATION – ALTERNATE TO DRIP AND SPRINKLER IRRIGATION

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ABSTRACT

Indian agriculture food basket is grown like a giant elephant with the advent of the green revolution, and later on, the micro-irrigation task force came into existence in India. The area under micro-irrigation is increased enormously, and the footprint of the crop yields reached pinnacle ranging from horticultural to field crops etc. The traditional micro-irrigation installation cost at the farm level is a big financial task that hinders the adoption and farmers looking for the govt policy support. There is a need to address this issue with best and most effective systems to facilitate the farmer at an affordable price. In this context, laser irrigation viz., laser spray, and laser drip irrigation are innovative, highly efficient conveyance systems with higher water use efficiency and in an affordable price range to small and marginal farmers, to bring more area under micro-irrigation to achieve more harvest in a wide range of crops.

INTRODUCTION

Micro-irrigation was an untapped potential during the early 20th century in the Indian agriculture scenario. In starting of the 20th century, the definition of irrigation took a new trackk as a Feed the crop-Not soil. The productivity of rainfed crops is always dictated by the quantity and pattern of rainfall received during the crop season. Farmer's income is consistently connected with rain, particularly in drought-prone arid districts of Andhra Pradesh (Reddy et al., 2020). However, a National Task Force Committee (NTFC), constituted by the Govt of India in 2003, has endorsed that 69 M ha of the area is suitable for micro-irrigation in India. A target of 14 M ha has been suggested for the 11th five-year plan (Yella Reddy & Satyanarayana, 2016). With the initiation of the task force on micro-irrigation and govt incentives, the area under micro-irrigation is increased enormously in India and a few other states like Andhra Pradesh, Maharashtra, Tamilnadu, etc. However, in the recent past, many studies revealed that drip and sprinkler irrigation deepen the water table depth in a few parts of Maharashtra and southern states due to the free power supply and automated irrigation switching systems. However, in districts like Ananthapuramu, the harvested water can be used as micro irrigation to enhance yields. Laser irrigation could be a possible alternative for micro-irrigation.

LASER IRRIGATION

Laser irrigation is an innovative alternative to drip and sprinkler irrigation techniques punched with laser holes at definite intervals to discharge minute droplets to the crop with both laser spray and laser drip irrigation.

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LASER SPRAY IRRIGATION

Irrigation as simulated light rainfall during the operation and runs with low pressure. The lateral pipes are laser punched with minute holes for water discharge in the form of sprays.

SPECIFICATIONS OF LASER SPRAY SYSTEM

- ✓ This is available in 32 mm and 40 mm diameter of laterals.
- ✓ The discharge of each lateral is 172-175 litres per hour per meter length.
- ✓ The wetting diameter of each laser punch is 12 m; however, the best results can be obtained at a 10m distance with 100 % overlapping.
- ✓ The Wall thickness of the lateral line is 0.3 mm.
- ✓ It can drizzle up to 5-6 feet (1.5 to 1.8m) height depending on the operating pressure.

Table: 01. Comparison of Laser spray vs traditional sprinkler irrigation system

Specification	Laser spray irrigation	Sprinkler irrigation
Spacing between laterals	6 X 6 m	12 X 12 m
Discharge (lph)	170	1500
Pressure (kg/cm^2)	0.7	1.5-2
Depth of Application (mm/hr)	28	10
Cost per acre (INR/acre) approx.	20000	25000
Radius of operation	4-5 m	10-12m

LASER DRIP IRRIGATION SYSTEM

- ✓ It can work at ultra-low pressure, i.e., 0.1 kg/cm^2
- ✓ The dripper discharge is 4lph, spacing between the dripper is 40 cm.
- ✓ Row to row lateral drip spacing is 1.2m (approximately 4 feet).
- ✓ The depth of application water per hour is 8.33mm.
- ✓ The time required for running 1 acre through laser drip is 36 minutes.

DURABILITY AND COST OF LASER SPRAY MATERIAL

Laser spray accessories are very cheap (approximately 16000 to 20000 INR/acre) compared to drip and sprinkler irrigation and can be affordable by every farmer and life span for 3-5 years depending on the usage and maintenance of the farmer.

Fig:01. Laser spray system irrigation system at ARS Research farm, Ananthapuramu

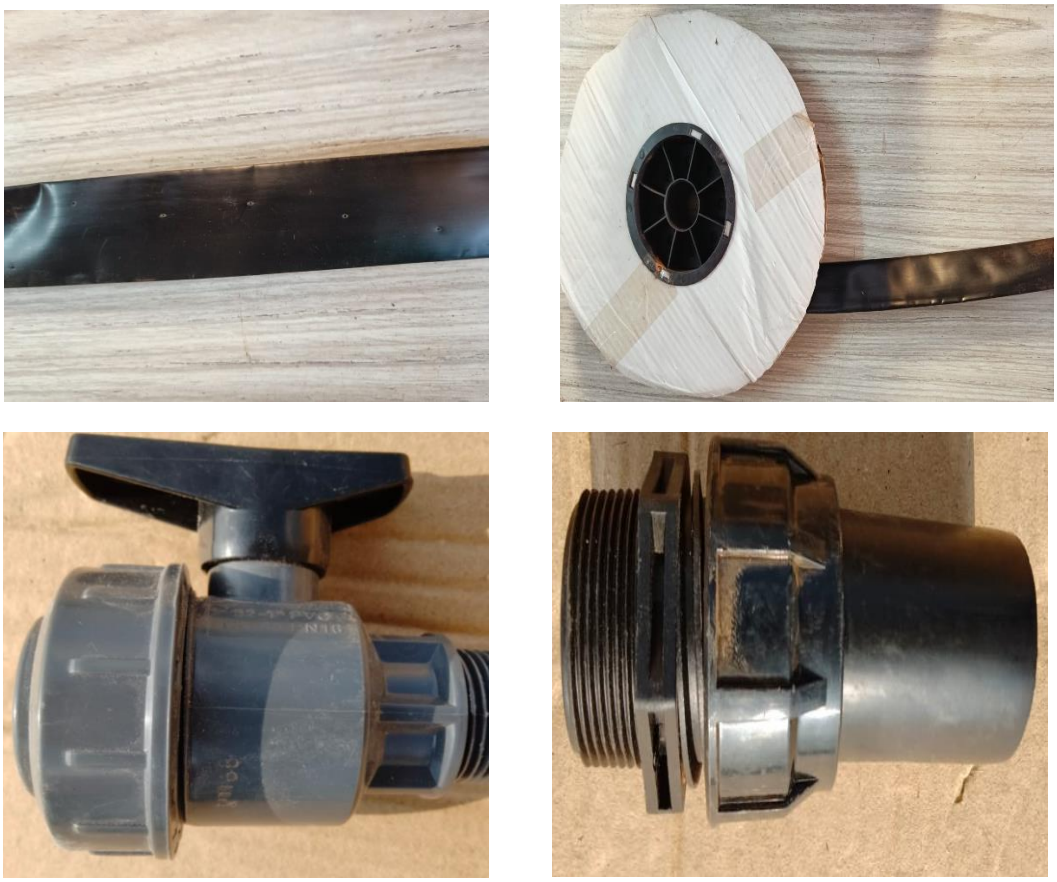

Fig: 02. Different accessories used in laser irrigation laser punched pipe, valve and laser end cap

Table: 02. Comparison of Laser drip vs traditional drip irrigation system

Specification	Laser drip	drip irrigation
Operating Pressure required at dripper discharge point (kg/cm^2)	0.1	1
Dripper discharge (lph)	4	4
Dripper spacing in the lateral (cm)	40	40
Row to row spacing of lateral (m)	1.2	1.2
Depth of application (mm/hr)	8.33	8.33

SUITABILITY OF THE CROPS

Laser irrigation can be adopted in a wide range of crops from suitable for leafy vegetables, onion particularly they enhance the humidity and alter the micro-climate for better yields in the summers particularly. In the hilly terrains of western ghats viz., Ooty, Munnar areas have little higher temperatures and require cool climates and higher humidity. Laser spray lowers air temperature by altering the micro-climate in that context. Laser irrigation is suitable for a wide range of field crops, cereals, pulses, and oilseed crops. Sprinkler irrigation may affect the flowering, pollination, fruit set etc., in certain crops, may be replaced with laser irrigation. Even it can be helpful in the horticultural crops and in greenhouses too.

CONCLUSION

Laser irrigation is at the infant stage in India. It can be studied in depth to a wide range of crops. The area under laser irrigation may increase the policy decision imparted to the existing micro irrigation methods, viz., drip and sprinkler irrigation. Further, it is high time to adopt better micro-irrigation techniques such as laser irrigation in a wide range of crops to upscale the farmer economic status by increasing productivity.

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NUTRITIONAL QUALITY OF THERMALLY PROCESSED FRUITS AND VEGETABLES

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ABSTRACT

Processing fruits and vegetables are necessary for preserving, producing a value-added product, and reducing the post-harvest losses in fruits and vegetables. The application of thermal processing has led to many products benefiting both producers and consumers. Owing to the impact of high temperature treatment on nutritional and sensory properties of food, many novel non-thermal processing techniques have been developed. However, even thermal processing has some beneficial effects as it enhances the bio-accessibility of some of the bioactive compounds existing in fruits and vegetables. Hence, both thermal and non-thermal processed products impact the overall availability of nutrients to the consumers.

INTRODUCTION

Processing of fruit and vegetables mainly include the application of heat. Even today, the most common method for processing food is the application of heat. It is required to reduce the enzyme activity, reduce the moisture content, and remove the microbial load. The use of thermal processing techniques such as blanching and drying has contributed much to many innovative processed foods. However, thermal processing leads to changes in foods' chemical, physical, sensory, and nutritional quality. Although thermal processing aims to reduce food spoilage by microorganisms, it results in undesirable modifications in sensory attributes, nutrients content, and bioactive compounds in many conditions. Besides being well established, scientific studies have shown the impact of thermal processing of fruits and vegetables on their nutritional quality; still, the high-temperature application remains the most efficient way of processing. However, to overcome this deprivation of nutrients, fortification of processed foods has also been attempted and successfully demonstrated.

IMPACT OF THERMAL PROCESSING ON NUTRITIONAL QUALITY

Many studies have shown that heat treatment can enhance or degrade the nutrients present in food during processing (Table 1). The bioavailability of lycopene was enhanced due to thermal processing. Studies have demonstrated that heat treatment ruptures the cell wall, favouring lycopene release from tomato chromoplasts and enhancing lycopene bioavailability/bio accessibility. The lycopene bio-accessibility was increased from 5.1 to 9.2 and 9.7 mg/kg at 60 and 90 °C blanchings, respectively, followed by boiling (Svelander *et al.,* 2010). Smoothie prepared from carrot juice-papaya-mango combination showed a better liberation and micellarization of carotenoids than an unprocessed raw smoothie. Upon mild

Table 1: Effect of thermal processing on nutrients present in fruits and vegetables

Product	Treatment	Bioactive compound	Per cent change on dry weight basis	Reference
Apple	Vacuum drying	Vitamin C	1.35 ↓	Joshi *et al.*, 2011
		Total phenols	9.31 ↑	
Starfruit	Freeze-drying	β-carotene	15.75 ↓	Shofian *et al.*, 2011
Mango			26.21 ↓	
Papaya			8.23 ↓	
Muskmelon			2.96 ↑	
Watermelon			43 ↓	
Starfruit	Freeze-drying	Ascorbic acid	6.41 ↓	Shofian *et al.*, 2011
Mango			0.23 ↓	
Papaya			1.62 ↑	
Muskmelon			22.76 ↑	
Watermelon			36 ↑	
Apricot	Canning	β-carotene	17.72 ↑	Adkison *et al.*, 2018
		Ascorbic acid	34 ↓	
		Phenols	47.70 ↑	
Jackfruit	Hot-air drying	Carotenoids	50 ↓	Saxena *et al.*, 2012
Guava	Freeze drying	β-carotene	26.27 ↑	Leiton-Ramirez *et al.*, 2020
		Lycopene	39 ↓	
		Ascorbic acid	62.12↓	
	Refractance window drying	β-carotene	4.26 ↓	
		Lycopene	29.57 ↓	
		Ascorbic acid	69.56 ↓	

(90 °C, 20 s), intensive heat treatment (120 °C, 20 s), and ultrasound treatment (60 °C, 20 min), β-cryptoxanthin liberation was found in the range of 3%, 10.3%, and 9%, respectively. However, mild heat treatment showed 34.2% liberation of β-carotene, but significantly higher micellarization was found in

intensive heat treatment for β-cryptoxanthin and β –carotene compared to the unprocessed raw smoothie (Buniowska *et al.*, 2019).

Moisture content often changes during processing, especially in thermal processing such as drying and storage. Removal of moisture to the extent of 5-15 % in fruits, vegetables, and green leafy vegetables resulted in the high value of bioactive compounds present per unit weight compared to fresh samples (Kumar *et al.*, 2020). As drying of fruit and vegetables enables easy transportation and preservation of commodities, the dried fruits and vegetables can be used as an ingredient without much being devoid of bioactive compounds. The thermal treatment enhances the bio-accessibility of carotenes and reduces the antinutritional compounds present in vegetables, including phytic acid, tannic acid, and oxalic acid. Conventional and microwave heat treatment in vegetables showed a significant reduction of these antinutritional compounds.

Similarly, amla, known for vitamin C content, cannot be consumed more as fresh due to high astringency, but processing amla into osmotically dehydrated segments can provide consumers about 20-25% of the required vitamin C per day without any astringency. In addition, the consumption of amla products rich in ascorbic acid and other iron-rich foods enhances iron absorption in our body. Moreover, many processed products are fortified with micronutrients which acts as a suitable vehicle for targeted and market-driven fortification.

Furthermore, freeze-drying of fruit and vegetables showed increased ascorbic acid content. Freeze drying of carrot, muskmelon and peach for 48–72 hours resulted in less than or equal to a 3-fold increase in ascorbic acid content. An increase in vitamin C content as a result of drying can be attributed to the inactivation of ascorbic acid oxidase leading to protection of ascorbic acid from enzymatic oxidation (Leong and Oey, 2012).

RECENT PROCESSING TECHNOLOGIES TO REDUCE THE NUTRIENT LOSS

Demand for high-quality foods by consumers with high nutrient content has led to the development of many new technologies in the food industry to preserve nutrients and prevent microbial spoilage. Novel thermal and non-thermal processing techniques such as ohmic heating, dielectric heating/microwave heating/radio frequency heating, pulsed electric field, ozone processing, ultrasound and high hydrostatic pressure processing may be used alone or in combination with other processing methods. Processing of foods using non-thermal technologies resulted in minimal or no changes in flavour, colour, and essential nutrients. Yildiz *et al*. (2009) Showed that the total phenolic contents of pomegranate juice did not alter much when ohmic heat was applied. High retention of lycopene and antioxidant activity was observed in watermelon juice when the high-intensity pulsed electric field was set up at electric field strength of 35 kV/cm for 50 μs at 200 Hz (Oms-Oliu *et al.*, 2009). High-pressure processing (600 MPa, 40 °C, 4 min) of fresh Navel orange juice resulted in better retention of the antioxidant activity compared to thermally pasteurized (80 °C, 60 s) juice during storage (Polydera *et al.*, 2005). Thus, the new non-thermal technologies can retain the nutrients present in fruit and vegetables during processing. At the industrial level, applying these technologies is a challenge as it involves standardization of process for product and the cost involved.

CONCLUSION

Thermal processing is a well-accepted processing method for value addition and food preservation. Even though thermal processing leads to some degradation of nutrients and bioactive compounds in fruits and

vegetables, some of them have shown to be more bio-accessible than their fresh counterparts. Changes in the nutritional quality of foods processed using high temperatures have led to novel non-thermal techniques. The application of non-thermal processing techniques resulted in the retention of nutrients in the product with appreciable sensory parameters and shelf life.

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INDIGENOUS KNOWLEDGE FOR WATER HARVESTING AND MANAGEMENT IN HOT ARID ZONE OF INDIA

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ABSTRACT

The Thar desert located in the north-western part of India is a large arid region . It covers around 6% of the country's total geographical area and forms a natural boundary between India and Pakistan. Scarcity of Water (annual rainfall 100-400 mm yr^{-1}), extremes of temperature (highest of 47-49^oC), and high population density of humans and livestock make this region the most vulnerable desert of the world. Droughts are widespread in this region. However, with centuries of experience, local dwellers have evolved to deal with surrounding environments. Communities have aligned their livelihood in harmony with local resources. Very sound, time-tested water harvesting structures like tanka, khadin, nadis, kund, jhalaras, kui etc. were developed to meet water requirements. This paper endeavours to illustrate indigenous knowledge for water harvesting and management in the hot arid zone of India.

INTRODUCTION

Throughout the arid and semi-arid regions, there are wide ranges of indigenous rainwater harvesting and conservation technologies. It is true for the Indian hot arid zone also. Typical characteristics of the Thar Desert include low (100-400 mm yr^{-1}) and highly variable rainfall (CV 35-65%), high-temperature regime, low humidity during the summer season, causing very high evapotranspiration (Goyal and Gaur, 2020). Even in average years, the weather condition for most of the year remains too dry and inhospitable for the successful growth of crops. The people of rural arid areas live in scattered settlements called *dhani's* distributed over sand dunes, interdunal plains and undulating landforms where organized water supply is neither feasible nor adequate water is available to fully meet the demand of thirsty land, humans and livestock (Gaur and Gaur, 2004). Under such circumstances, every drop of water become very precious. People of this region have developed indigenous technologies for rainwater harvesting and conservation. These technologies are site-specific, time-tested, and proven for soundness in extreme conditions. People are conversant with these conservation technologies that require minimum maintenance costs. There is a need to revive these technologies, modify them if needed and extensively propagate in the field. Some of the important indigenous technologies of Indian hot arid for water management are described here:

The common terms for different kinds of water in arid zone

- ✓ Palar water: Rainwater
- ✓ Patal water: Groundwater extracted through wells and tube wells
- ✓ Rajani/Rejani water: Potable Water between transition zone of ground and surface water

KHADIN

Khadin is a unique practice of runoff harvesting for crop production in hyper-arid region of Rajasthan developed on the principle of rain water harvesting . These are built across the lower hill slopes below the gravelly uplands around 100-300 meter long earthen embankment. In this system exceess water drains off through sluices and spillways. It is suitable for deep soil surrounded by some natural rock outcrops constituting a catchment area. The khadin has great promise to enhance crop production in hyper-arid regions like Jaisalmer (Goyal *et al.*, 2018).

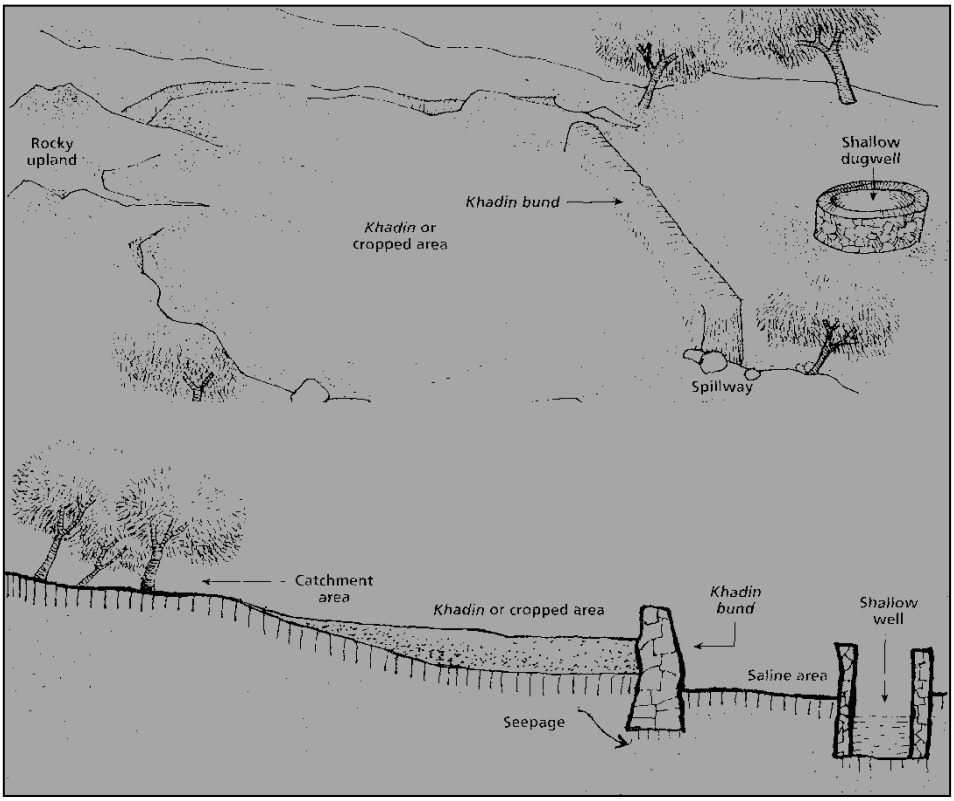

Fig-1. Khadin system of runoff farming

NADIS

Nadis are village ponds used to store runoff water from adjoining natural catchments during the rainy season. The site selection of *nadi* is based on availability of natural catchment and its runoff potential. Water availability in *nadi* ranged from 2-12 months after the rainfall. *Nadis* received water supply from erratic, torrential rainfall. Since *nadis* received runoff from sandy and eroded rocky basins, large amounts of sediments used to deposit regularly in them, resulting in quick siltation. High evaporation and seepage losses through porous sides and bottom, heavy sedimentation due to biotic interference in the catchment and contamination are major bottlenecks. *Nadis* are 1.5 to 4.0 meters deep in dune areas, and those in sandy plains vary from 3 to 12 meters. Planting suitable tree species around the *Nadi* creates an oasis in the desert and improves the local environment (Goyal *et al.*, 2009).

Fig-2. Improved *Nadi* with LDPE lining

TANKAS

Collection and storage of excess rainwater in *tankas* (underground cisterns) is an age-old tradition for meeting domestic water requirements. Until today, most of the villages depend on these structures as a source of drinking water. Tankas were usually constructed near religious centres and in villages for community usage due to the belief in the sanctity of water. Besides this, every household used to have underground tanka of varying capacity from 5-15 thousand litres. Prominent families used to have more than one tanka in their homes. Community tanka of 3-5 lakhs capacity was found the arid region. Smaller tankas are generally connected with rooftops for rainwater harvesting. However, an artificial catchment was constructed for larger/community tanka rainwater harvesting. When tankas did not get adequate rainwater during subnormal rainfall, water is hauled in camel/bullock carts from nearby wells/*nadis* to fill the household *tankas*. Construction of tanka on an individual family basis has a psychological impact of pride of ownership to the beneficiaries. Tankas' rainwater harvesting system and its recycling for life-saving irrigation can provide an effective check against dry spells and drought for economic yields (Goyal *et al*., 1997).

Kunds/Kundis

The Kunds/Kundis are typical rainwater harvesting structures of the Thar Desert of Rajasthan. The main difference between tanka and kunds is the location and shape of the structure. The Kunds are constructed outside the home, whereas tankas are typically constructed inside the house. The shape of traditional tankas is rectangle depending on the available space within the house, whereas kunds are essentially circular in shape. The catchments of kunds are made with lime and mortar for higher runoff generation (Gaur *et al.,* 2018). The sidewalls of kunds are covered/plastered with lime and ash whereas, kunds have a dome-shaped cover to protect the water. Large public kunds have been in practice for the poor people in the region. The kund system of rainwater collection is very effective even in rainfall as low as 100 mm.

KUIS/BERIS

Kuis/Beris is a unique water harvesting system in the hyper-arid region of western Rajasthan. A *kuis* is a very small dug well (kuan), kuis is feminine, and kuan is masculine. The *kuis* is small only in width; its depth is quite deep as far as its depth goes. *Kuis* or *beris* usually are 5 meters (m) to 12 m deep with a very narrow opening. The *kuis* differs from the normal well (*kuan*) in another way that *Kuan* is dug to tap the water table, but the *kuis* does not access the water table the same way as the *Kuan* does. The *kuis* collects rainwater in an exceptional way. This system is relies on the principle of collection of percolated rainwater deep down from the sandy terrain. To harvest percolated rainwater deep from sandy soils, a

narrow and deep pit known as *kuis/beris* in local language used to be constructed in the sandy catchment. *Kuis* are generally found in the Jaisalmer and Barmer districts of Rajasthan, where rainfall is very low, and groundwater is very deep and saline.

Fig-3. Traditional Kunds

BAORI /BAWDI

Baoli/Bawdi are step wells usually found in Rajasthan, Gujarat and some parts of northern India. The main purpose of constructing these stepwells is primarily to provide domestic water safety and ease to the local people without buckets and rope. *Baori* is normally rectangle in shape with steps on three sides. The main source of Water in the Baori is essentially groundwater. Therefore, these are usually more than 50 feet deep. *Baori* is a bigger structure and requires a lot of labour and material; therefore, these are often constructed with community participation and, most of the time with the help of local support. *Baori* also serves the purpose of a common place of gathering for social function and a resting place for outside travellers. Due to indiscriminate groundwater exploitation for various purposes, the water table is declining faster, and most stepwells dried up except a few with tourism attractions. There is a need to encourage groundwater recharge in these areas.

JHALARAS

Jhalaras are human-made water harvesting structures similar to *Baori* found in Rajasthan and Gujarat. *Jhalara's* water is primarily meant for community use and religious rites. The main difference between *Baori* and *Jhalaras* is an essential source of water. The primary source of water in *Jhalaras* is surface water. The *Jhalaras* collect subsurface seepage of a *talab* or a lake located upstream. Surface runoff from the surrounding catchment is also allowed to collect in *Jhalaras.*

JOHADS

Johads are simple stone/mud/dead vegetation barriers built across the contour on sloping land to arrest rainwater. Johads have high embankments on three sides, while the fourth side is left open for rainwater to enter. The main difference between *Naada/Bandha* and *Johad* is that the former is constructed on streams/channels, whereas the later is constructed on contours across the slope. A *Johad* prevents rain water from running off, allowing it to percolate into the ground, recharging water aquifers and improving

the earth's water balance. *Johads* have played a very important role in the rejuvenation of the *Arvari* and *Ruparel* rivers through rainwater harvesting and groundwater recharge in the Alwar district of Rajasthan (Sharma, 2006; Das, 2010)

CONCLUSIONS

Drought-proofing, mitigation and relief strategies are the needs of the hot arid zone of Rajasthan subjected to frequent droughts. Traditional social, cultural, religious, spiritual, and people's science has greater significance for mitigating drought and combating desertification in the great Indian Desert. Indigenous governance of water is needed from social and environmental points of view, and a means to ensure water as a human right. With all their respective aspects, the rediscovery of traditions can restore and create just and sustainable livelihoods in India and globally.

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APPLICATION OF HYPERSPECTRAL REMOTE SENSING DATA IN SOILS

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ABSTRACT

Rapid and reliable assessment of soil properties is an important step in agriculture. Over the last few decades Hyperspectral spectroscopy has emerged has a new tool to obtain soil information. These are capable of covering large areas with exceptional spatial, spectral and temporal resolutions. Some researchers tried to make spectral libraries of Indian soils but it is not success in all situations. Thus, there is a need to work more intensely on hyperspectral data to extract full of its potential for predicting soil properties.

INTRODUCTION

Hyperspectral Remote Sensing (HRS) is a new technology investigated by researchers and scientists to identify minerals/elements present in the soil. HRS is the science of acquiring digital imagery of earth materials in many narrow contiguous spectral bands. It helps for the precise recording of the spectrum and a detailed analysis of the spectral analysis of the soils. The term “hyper” in hyperspectral means “over” and refers to a large number of measured wavelength bands. These methods are fast, non-destructive and have large spatial coverage. The four factors that affect soil signature are mineral composition, organic matter, soil moisture, and texture. This imagery provides the potential for more accurate and detailed information extraction than any other type of remotely sensed data.

MULTISPECTRAL VS HYPERSPECTRAL IMAGERY

The important difference between Multispectral and Hyperspectral Imagery is the number of bands and the narrowness between the bands. Multispectral imagers like Landsat, SPOT, etc. measure radiation reflected from a surface at a few wide, separated wavelengths, whereas hyperspectral imagers like Hyperion measure reflected radiation at a series of narrow and contiguous wavelengths bands (Figure.1). Generally, multispectral have 3 to 10 bands, whereas hyperspectral imagery consists of hundreds or thousands of bands.

Hyperspectral imagery is very helpful in identifying certain objects and minerals if an analyst has good knowledge about their spectral properties. In multispectral imagery, the analysis and interpretation part is much easier than hyperspectral imagery due to a minimum number of bands. Multispectral remote sensing has a poor spectral resolution compared to hyperspectral.

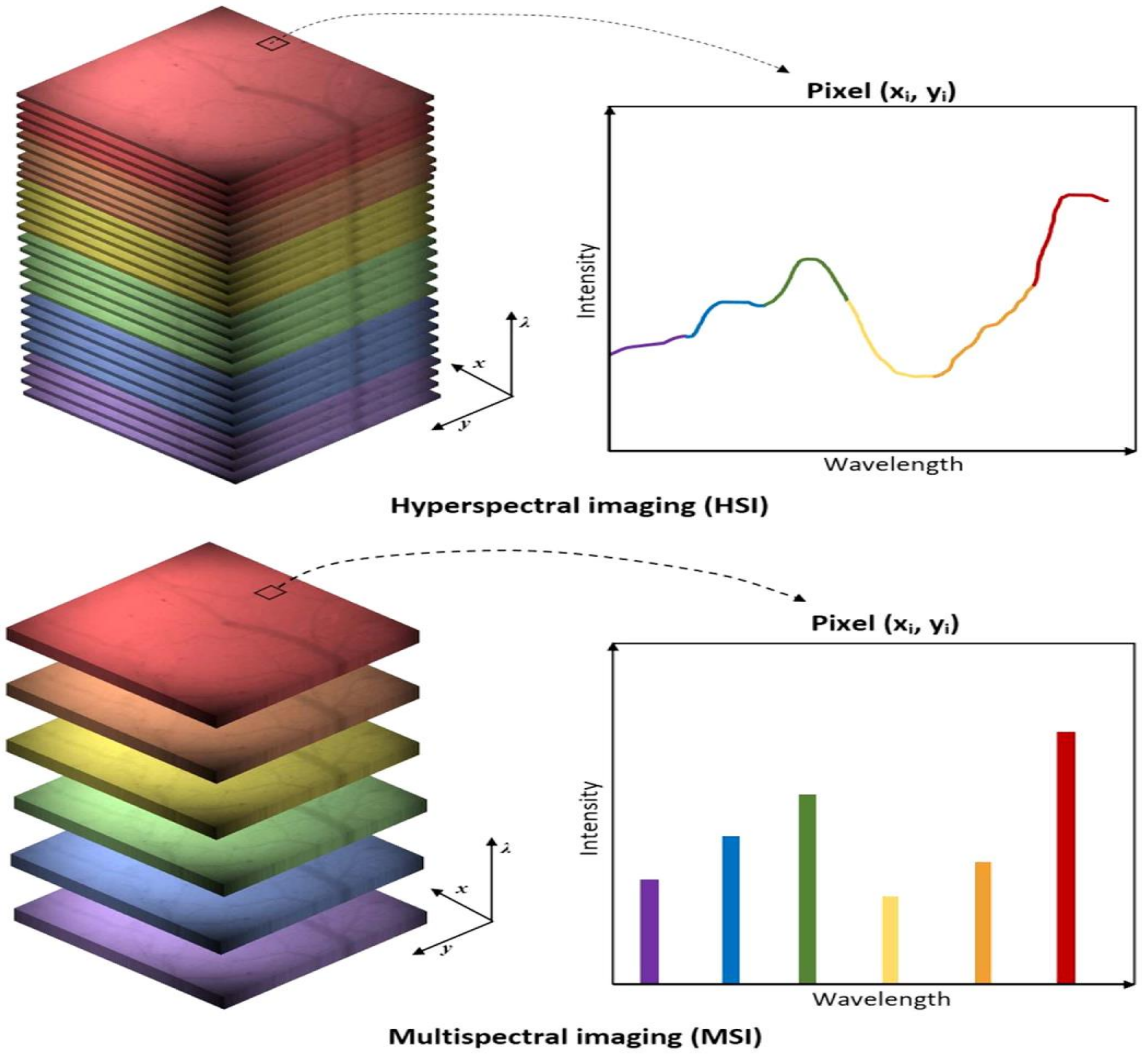

Figure.1 Spectral comparison between Hyperspectral and Multispectral Imagery

CONCEPT IN HYPERSPECTRAL REMOTE SENSING

Hyperspectral imagery is characteristically composed as a data cube with spatial information composed in the X-Y plane, and spectral information represented in the Z-direction (Figure.2). It is a technique that assigns primary colours (red, green, blue) to each pixel and analyses a wide spectrum of light. When the light strikes on the pixel, each pixel is broken down into many spectral bands and provides huge information on what is imaged. Some materials reflect a certain wavelength, while some absorb the same wavelength. This pattern of reflectance and absorption is helpful to identify certain materials. Unlike other optical methods that can scan only single colour, HRS can distinguish the full-colour spectrum in each pixel. Thus, it provides information in addition to 2D spatial images.

When the measured spectral reflectance of thousands and more materials are assembled and compiled is referred as a spectral library. Soil reflectance library of soils of India in the electromagnetic spectral region of 350-2500 nm using ASD spectro-radiometer was prepared by Saxena et al., 2005. This spectral library contains reflectance spectra of 128 soil samples collected from different agro-ecological regions.

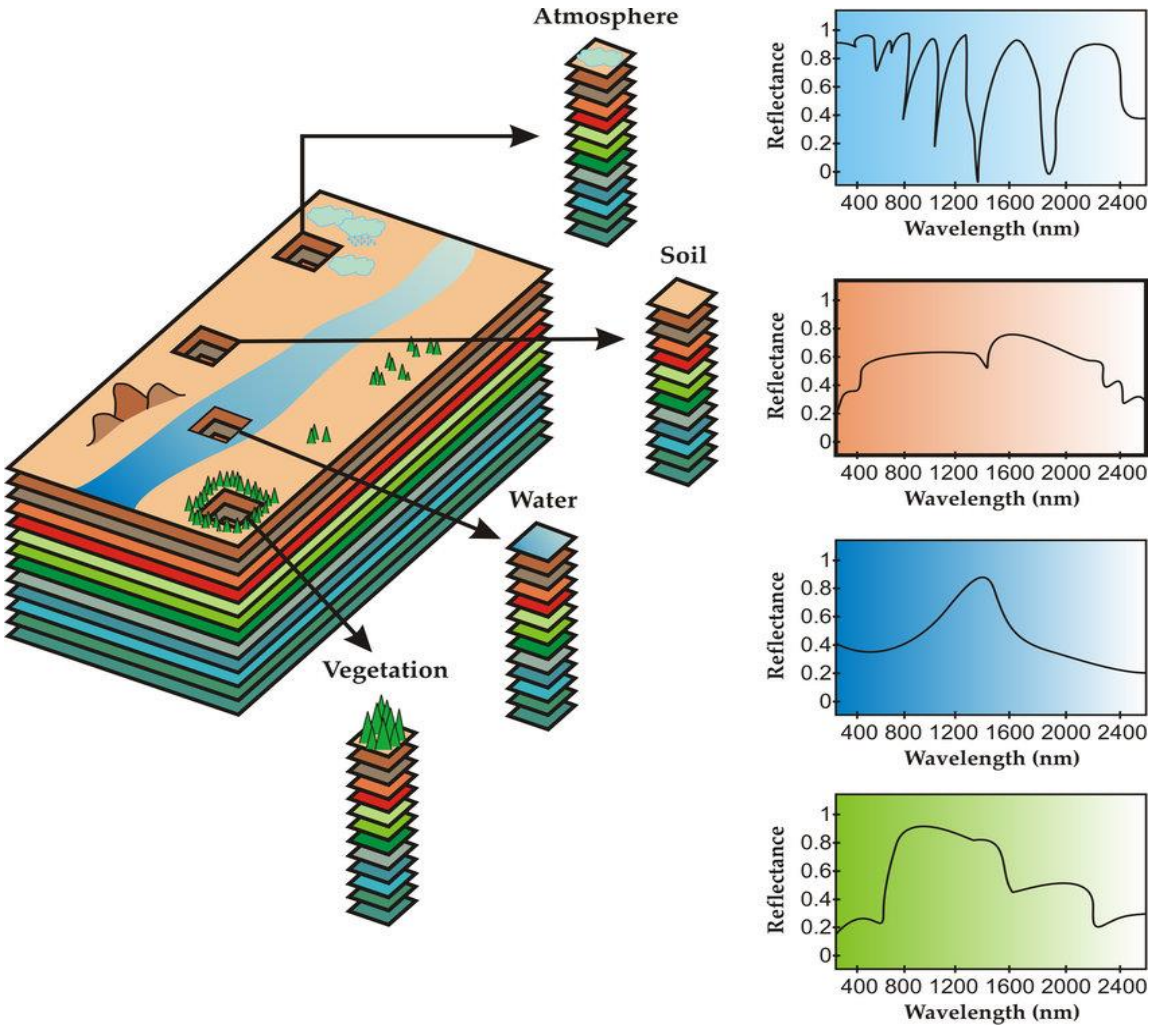

Figure.2 Concept of Hyperspectral Imagery

PREDICTION OF SOIL PROPERTIES

Soil reflectance data have been successfully used to forecast some physical, chemical and mineral soil properties (Gomez et al., 2008; Viscarra et al., 2006; Reeves et al., 2002). The approach also allows estimation of multiple soil properties from the same spectral information, but is limited by the requirement for a rational number of samples to calibrate and validate the predictive models. The raw spectra is pre-processed using Savitzky-Golay First Derivative (SGFD) and Savitzky-Golay Second Derivative (SGSD) algorithms. The various parametric and non-parametric algorithmic methods are used in the prediction process. Majority of the soil spectroscopic studies conducted so far used PLSR (Kinoshita et al., 2012) or modified PLSR (Cozzolino and Moron, 2003) as a parametric method for model calibration and Artificial neural networks (ANNs) as a non-parametric method. There are many other algorithms used like Multiple Linear Regression (MLR), Enter Multiple Linear Regression (EMLR), Stepwise Multiple Linear Regression (SMLR) etc. for model calibration. However, some samples in the dataset showed relatively

large variations between the measured and predicted values for different soil variables and the reasons thereof need to be explored using a large dataset both for calibration and validation.

CONCLUSIONS

Among the advanced remote sensing techniques, hyper-spectral spectroscopy plays an important role in identifying and detecting materials. Various statistical methods and algorithms are used to utilise hyper-spectral data efficiently. Thus, there is a need to research hyper-spectral data so that the information derived can be precisely correlated and inferences can be drawn.

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SCHISTOSOMA INFECTION IN VERTEBRATE

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ABSTRACT

Parasites are very primitive organisms and were residing from 512 million years. Parasitic infestation adversely affects the global livestock business and has harmful consequences on the country's growth. Schistosomiasis is a tropical disease of significant public health importance and can be observed both in humans and animals, resulting in morbidity and mortality in Asia and Africa. It also affects the economy of people and nations. The current manuscript provides us ephemeral knowledge about some vital features of Schistosomiasis like morphological character, general appearance, different species, pathogenesis, clinical sign, control and treatment of infection. It can be helpful to the end-user and may reduce human and animal infection.

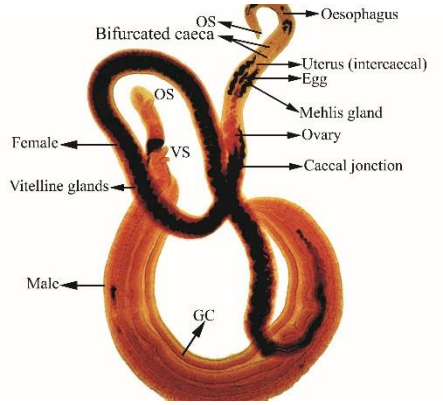
INTRODUCTION

According to a survey, on the whole, India has 535 million livestock population, out of which bovine, sheep and goat count is 302.3, 74.3 and 148.9 million, respectively (https://www.nddb.coop/information/stats/pop). Animal are mainly used for both milk and meat purposes and contribute to a large part of farmer and country economy. The health and productive status of these animals are affected by various parasites and out of which *Schistosoma* species infection play a vital role. The current popular article deals with various crucial aspects of *Schistosoma* such as morphology, general appearance, different species, pathogenesis, clinical sign, control and treatment.

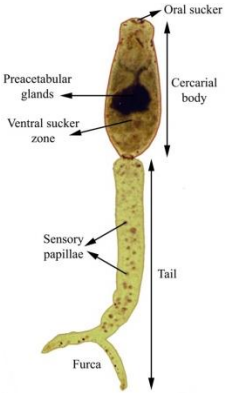
GENERAL STRUCTURE OF *SCHISTOSOMA* SPECIES

Schistosoma species, also known as "blood flukes ", mainly reside in their definitive host's blood vessels; they have elongated bodies and both sexes, i.e. male and female, are different individuals. The body of male is short, thick with turbeculated tegument, whereas the female body is long, thin with smooth tegument. Male has gutter like gynaecophoric canal, which is used to carry females during copulation. Organ of attachment i.e. oral and ventral sucker are positioned at anterior end. Digestive system is incomplete and starts from oral sucker followed by oesophagus and then intestine. Intestine divide in 2 caeca but at posterior end they join again. Circulatory system is absent whereas reproductive is well developed, male has 3-8 testes and are places near ventral sucker, and it is followed by vas efferentia and seminal vesicle. Female consist of ovary followed by oviduct, vitelline glands, ootype and uterus. Eggs come through genital pore and are non-operculated, thin shelled and are provide with terminal or sub terminal spine and they are voided in faeces, urine or nasal discharge (Soulsby 1982, Bhatia et al 2016).

APPEARANCE OF PARASITE



*Male and female fluke**



*Furcocercous cercariae**

*https://www.waterpathogens.org/book/schistosoma

Difference species along with their host and area of location

S. No	Species	Definitive host (DH)	Location in DH
1	*S. bovis*	Ruminants, equines, camels, rodents, man	Portal and mesenteric vein
2	*S. japanocium*	Ruminants, equines, dogs, cats, rodents, man	Portal and mesenteric vein
3	*S. mattheei*	Ruminants, equines, baboons, rodents, man	Portal and mesenteric vein and urinogenital tract veins
4	*S. spindale*	Ruminants, dogs	Mesenteric vein
5	*S. indicum*	Ruminants, equines, camels	Portal and mesenteric vein
6	*S. mansoni*	Man	Mesenteric vein
7	*S. haematobium*	Man, monkey, baboons, rodents, pigs	Mesenteric arteries, bladder, ureters and urethra
8	*S. nasale*	Ruminants, equines	Nasal mucosa veins
9	*S. incognitum*	Dog, pigs, sheep, goat	Mesenteric vein

LIFE CYCLE

At the time of laying eggs, an adult female goes deep inside the small blood vessels of the intestine mainly at mucosa or sub-mucosa level and ultimately lays a fertile egg in capillaries. Eggs mainly has spine and pierce the blood capillary and other structure along with intestinal wall thus reaching in the lumen of intestine. At the time of laying, the egg is not fully mature and its development continues until they are voided off in the faeces of the definitive host. Egg hatch as soon as it gets water and miracidium comes out. Hatching depends on other factors like temperature, light exposure and salinity of water. Miracidium swim with the help of cilia and after finding the appropriate intermediate host i.e. snail (*S. mattheei* infect *Bulinus*

sps, *S. japonicum* infect *Oncomelania* sps, *S. mansoni* infect *Biomphalaria*, *S. haematobium* infect *Bulinus* sps, *S. spindale* infect *Planorbis, Indoplanorbis, Lymnaea* sps) penetrate its tissue and form a sac like structure known as "mother sporocyst" after casting off its cilia. This mother sporocyst procedure daughter sporocyst and in the end cercariae is formed. Generally ceracriae has forked tail so it is also known as "furcocercous cercariae", it come out from snail body actively and swim in water body. With the help of secretion (hyaluronidase enzyme) from cephalic gland cercariae directly penetrate the body of DH. After penetration, the tail's cercaria cast forms globular structure also known as schistosomula. It is then carried away via circulation to lungs and at last liver. Pairing of male and female worms takes place in portal veins and reaches maturity in mesenteric veins and starts laying eggs (Soulsby 1982, Bhatia et al 2016).

PATHOGENESIS

Pathogenesis caused by *Schistosoma* sps is both mechanical and immunological and depends upon the parasite's location in DH. There are many form of pathogenesis which is given as under:

(1) *Intestinal form*- It mainly occurs in acute condition and develops due the presence of adult female and large number of egg in intestinal mucosa. Large number of haemorrhagic lesion is formed on mucosa of intestine mainly in posterior small intestine and caecum but it can also extend from fore-stomach to rectum of GIT. Haemorrhagic ulcers are seen on mucosa, oedematous exudate and blood stained mucous is also formed. Infiltration of immune cells such as eosinophil, lymphocytes, macrophages, and plasma cells occurs in lamina propria. These immune cells attack the eggs and thus eggs may be found free or micro abscess/granuloma can also form. In the last eggs are degenerated by immune cell and sometime fibrous tissue formation take place by action of epithelioid and fibroblast cells. Phlebitis can also occur in mesenteric vein by presence of adult parasite. In *S. indicum* pseudo-abscess are formed in intestinal wall and in equine these areas can be easily identified by the presence of black pigmentation.

(2) *Hepatic form* is mainly an immunological reaction against the parasitic egg. Egg shell has pores and through which soluble antigen is released and sensitizes the immune response in host. Mobilization of various immune cells such as eosinophil, macrophages and lymphocyte occur toward the egg, and inflammatory reaction starts along with the destruction of the egg. In later stages epithelioid cell, giant cells and fibroblast cells come into the place, fibrous tissue formation starts and ultimately lead to the formation of clay-pipe stem condition. Fibrous tissue formation sometime alters the flow of venous portal blood so there may be compensatory neovascularization and increase in blood flow.

(3) *Nasal form* is caused by *S. nasale* mainly in cattle whereas buffalo act as carriers. Parasitic eggs are found in mucosal gland of nasal cavity and result in the formation of military abscess (nasal granuloma) via cellular reaction. Sometime rupture of old abscess take place and again new abscess is formed; this can ultimately lead to fibrosis and cauliflower like growth. Mobilization of eosinophil, plasma cells, lymphocyte, macrophage, fibroblast and giant cells to infection site take place. Infected animal produce snoring sound and it can also lead to rhinitis, mucopurulent discharge, sneezing and dyspnoea.

(4) *Urinary form*- It is mainly caused by *S. haematobium* in the lower urinary tract and urinary bladder wall. Presence of egg lead to delayed type of hypersensitive reaction and formation of granuloma. Granuloma formation can also lead to obstruction in urinary bladder and ureter. Sometime ureteritis and appendicitis also develop.

(5) *Dermatitis form*- It is known as cercarial dermatitis, swimmer itch, dhobi itch, hunter itch, rice paddy itch. This is an occupational condition caused by penetration of avian origin cercariae into the skin of human

who usually work in pond, river side, ditch, rice paddy field or other water logged area. Skin penetration lead to mild erythema, oedema, pruritus, popular or pustular eruption followed by dermatitis.

CLINICAL SIGN

Acute infection leads to diarrhoea, dehydration, anorexia, anaemia, hypoalbuminemia and oedema. Chronic infection leads to emaciation, eosinophilia, anaemia, hypergammaglobulinemia (Soulsby 1982, Bhatia et al 2016).

DIAGNOSIS

Clinical sign, serological test such as miracidia immobilization test, cercarien hullen reaction test, circumoval precipitation test, haemagglutination test, complement fixation test, ELISA (Soulsby 1982, Bhatia et al 2016), molecular test such as PCR.

TREATMENT

Oxamniquine @ 15-20 mg/kg, trichlorophon @ 100-200 mg/kg in sheep, niridazole @ 25 mg/kg in pig, praziquantel 10 mg/kg in cattle, buffalo, sheep, goat. Tatar emetic @ 2 mg/kg and sodium antimony tartrate @ 1.5 mg/kg in case of nasal form (Soulsby 1982, Bhatia et al 2016).

CONTROL MEASURES

Destruction of IH by use of insecticide such as copper sulphate, sodium pentachlorophenate etc, rearing of snail eating ducts, use of spores of predacious fungi, use of larval stage of *Echinostoma* sps, use of *Nosema eurytremae,* segregation, treatment of infected animal, reduce contact of livestock and snail infested water bodies (Soulsby 1982, Bhatia et al 2016). Many vaccination agents had been tried to reduce *Schistosoma* infection. Sh28-GST (Bilhvax), Sm29, SmCD59, Sm200, Sj23, Sj62, Sj28, Sj14, SjCTPI, *S. mansoni*-TSP-2 and SmTOR had been used to produce immunity in the definitive host (Sumbria and Singla 2015). Control of snail can be achieved by three ways:

1. Physical: Net in water channel in farms/ flow of water, destruction of breeding ground.
2. Chemical: Copper sulphate (1:100000) or 10-35kg/hectare, N-tritylomorpholine (0. 45kg in 680litres/hectare), Cuprous chloride (5ppm), Niclosamide .
3. Biological: Duck and goose rearing, Fish (Black Carp), Nymphs of dragon fly, Predatory Prawn (*Macrobrachium vollenhoveni*), Water bugs (*Sphaerodema urinator)* and Plant extracts.

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