



# Musk Melon Cultivation on Reservoir Basin: A Climate Smart and Profitable Farmer Practice in Arid Zone of Rajasthan

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**Abstract:** Small-holder farmers everywhere have been necessitated to develop location-specific knowledge and adaption techniques in order to maintain their livelihoods in uncertain ecosystems due to climate vulnerability and several stresses. The growing of muskmelon on the reservoir basin has also been made profitable by a climate-smart technique developed by local western Rajasthan farmers. The developed technology is primarily a conservation agriculture technique that includes the use of short-duration varieties, decreased tillage, low fertilizer inputs, no irrigation, and the use of locally accessible mulch to minimize evapotranspiration. The findings indicated that musk melon production in the reservoir basin under conserved soil moisture (CMLI) with modest inputs had a minimum days taken to first flowering (29.70 days), first harvesting (82.40 days), high benefit-to-cost ratio (3.64) and net return per day (Rs. 2980 ha<sup>-1</sup>) than the conventional method (AMHI) of cultivation in which days taken to first flowering (35.40 days), first harvesting (91.10 days), high benefit-to-cost ratio (2.94) and net return per day (Rs. 2646 ha<sup>-1</sup>), which involved ample irrigation and inputs. In contrast to conventional cultivation practices, the high benefit cost ratio under conservational technology was mostly related to low cultivation costs as well as significant income from early fruit harvest.

**Keywords:** Semi-arid climate, Conserved moisture, Agroecological knowledge, Opportunistic autonomous adaptation, Muskmelon

Crop production is exceedingly difficult in Rajasthan's arid and semi-arid region because of the harsh climate conditions, scarce and poor quality of soil and water resources. In these regions, only hardy crop species with minimal water requirements are produced, mostly in the *khari* or *rabi* seasons when guaranteed irrigation is available (Singh et al., 2019). Sand dunes, sand plains of varying thickness (some of which are salt-affected), as well as some desolate hills, uplands and gravelly pavements make up the majority of Rajasthan state's (2,11,867 km<sup>2</sup>) arid western region, which includes a significant portion of the Thar or the great Indian sand desert (Santra et al., 2013). Over 85% of the region's yearly rainfall falls (June-September) during the south west monsoon, ranging from about 500 mm near the slope of the Aravallis in the east to about 100 mm along the border with Pakistan in the west (Singh et al., 2023). The mean annual potential evapotranspiration is significantly more than precipitation (1400-2000 mm). This region experienced 42 severe droughts during the years 1801 to 2002, which decreased agricultural output (Saxena and Mathur 2019). High biotic pressure on dry areas accelerates the development of desertification and decreases crop productivity, which leads to an exploitation of the area's resources (Gupta and Narain 2003). Crop failure is a common occurrence caused by either insufficient rainfall or a deficiency of soil moisture to meet the crop's water needs during various phenological stages (Barnabas et al., 2008). In addition, the dry region has a number of biotic and abiotic constraints that contribute to its low production. Local

farmers used their agro-ecological knowledge in these conditions to shift stress into opportunity with self-adaptation (Faroda et al., 2007). One such evidence is the winter and summer time production of fruits and vegetables in the reservoir basin in Rajasthan's desert region.

Due to the low rainfall, farmers and populations in dry zones were compelled to build reservoirs to collect and store rainwater during the rainy season and use the stored water for irrigation and drinking during the winter and summer (Singh et al., 2019). Due to ongoing water extraction for irrigation, drinking and other purposes as well as evapotranspiration, the water level in this reservoir began to decline throughout the winter and nearly reached an all-time low during the summer. The reservoir then opens up a significant amount for farming (Varghese and Singh 2016). The reservoir basin's soil fertilizes with increased water retaining capacity as finer soil particles are gradually deposited. The small and landless farmers residing in the catchment area of the reservoir realized the potential of the soil of reservoir basin and started to cultivate it for the production of vegetables on residual soil moisture. However, the crop yield and profitability were poor due to fast depletion of soil moisture in the absence of soil moisture conservation technologies (Singh et al., 2020). A number of indigenous knowledge or methods have gradually developed to improve the preservation of remaining soil moisture as well as the productivity and profitability of the farming in this region (Singh et al., 2023). An example of such an indigenous technique is the cultivation of musk melons using indigenous

knowledge that is comparable to the current approach of conservation agriculture in the reservoir basin of the Hemawas Dam, Pali (Rajasthan). Therefore, we assessed and evaluated the socio-economic features of locally evolved conservation agricultural practices for musk melon cultivation in the reservoir basin of the Hemawas dam with traditional musk melon production methods.

## MATERIAL AND METHODS

**Study area:** The two villages of the Pali district of the Rajasthan (India) were selected for the study. The first study location was reservoir basin of the Hemawas dam, in the Hemawas village which was built in 1911, lies on the Bandi river (a tributary of the Luni river) and the catchment area (reservoir basin) of the Dam is about 1,685 km<sup>2</sup>. The second location was the Naya Gaon village of the Sojat tehsil in the Pali district of the Rajasthan State, India. The Pali district's climate differs just little from that of the typical arid western Rajasthan. The significant temperature variation is observed due to nearby green and hilly terrain, even though the summer season the temperature rises to 46-47°C (May-June). The temperature falls to 4-5°C in December-January, and winters are moderately cold. The during monsoon (July to October) the average rainfall is 450.7 mm. The soil in the study areas was sandy clay loam, salty nature (brought on by limited rainfall and excessive evaporation) with following characteristics:-

Particulars of soil	Value
Depth of soil	50 to 75 cm
pH	7.73 to 8.20
Organic carbon	0.22 to 0.33%
Nitrogen (N)	231.75 to 277.00 kg/ha
Phosphorus (P <sub>2</sub> O <sub>5</sub> )	14.33 to 15.00 kg/ha
Potash (K <sub>2</sub> O)	210.33 to 214.33 kg/ha

**Selection of farmers and data collection:** The data was collected from ten musk melons farmers in the Naya Gaon village (25.9238° North latitude and 73.6651° East longitudes) and Hemawas dam (25.7343° North latitude and 73.3620° East longitudes) for three-year (2018, 2019 and 2020) on all agronomical approaches, plant growth, development and yield features from twenty five muskmelon plants selected from each location. Data were collected on various parameters, including length of vine (m), number of leaves per vine, days to first flowering, days to first female flowering, days to first harvest, number of fruits per vine, fruit weight (g), fruit yield per vine (kg), fruit yield (t/ha). The economics were calculated based on the cost of cultivation and the price of fruit through at the time. The productivity per

day (kg/ha) and total yield per day (Rs/ha) were converted to total yield and total net return per days, respectively. The benefit cost ratio was determined by dividing the absolute net return and cultivation cost.

**Statistical analysis:** This was carried out using OPSTAT software (Sheoran et al., 1998).

**Land availability in the reservoir basin:** The Hemawas Dam's reservoir fills up almost completely during the rainy season, making the basin unusable for growing crops from July through September, or the *kharif* season. Following monsoon withdrawal, the water level in the reservoir gradually declines quite quickly as a result of water extraction for drinking, irrigation of *rabi* crops, seepage and evaporation. Due to water receding by October, a significant section (about 65–70%) of the reservoir basin at a higher altitude is open for growing *rabi* crops. The reservoir is nearly empty (approximately 95%) in early December as a result of water extraction, in this basin only *rabi* crops, and cucurbits vegetables are grown in conserved moisture.

### Agronomic Practices

**Conservational cultivation in the reservoir basin (conserved moisture with low inputs, CMLI):** After the availability of land as a consequence of the reservoir's water level reducing (November-December), marginal and small farmers in the area started breaking up hard pans in January. The indigenous short duration variety (locally known as KAJRI) musk melon was sown in last week of January to fortnight of February. The farmer excavated pit holes of 4-6 cm in with 1.80 m difference between rows and 50 to 75 cm between plants. Six to eight treated seeds are sowed and covered with sand in each. The farmer covers the seedlings with locally available materials dry plants, such as *Crotalaria burhia* and *Leptadenia pyrotechnica*, to conserve moisture and minimize evaporation after the seeds have germinated within five to six days. The light soil ploughing is done when the plant reaches a height of 10 to 15 cm in order to preserve soil moisture.

**Agronomic practice in the conventional cultivation (adequate moisture with high inputs, AMHI):** In a conventional farming method, the field is prepared by conventional tillage during bed preparation and seed sowing in early February. Before to final leveling, the recommended dose of fertilizer dosage was applied. Seeds were sown during 2<sup>nd</sup> week of February on 2.0 m wide bed in two rows at 120 cm apart at 30 cm plant to plant spacing and 1-2 cm soil depth with 1 seed per hill. All recommended practices were followed (Patil et al., 2014).

## RESULTS AND DISCUSSION

**Crop growth and fruit yield of muskmelon:** Perusal of

mean data of three years (2018 to 2020) showed that all growth and yield of the musk melon was significantly influenced by both type of the cultivation practice. The growth, development and fruit yield was significantly higher in conventional methods of cultivation as compared to traditional conservational practices (Table 1 and 2). In pool data significantly higher growth length of vine (2.18 m) and number of leaves per vine (80) of plant was recorded under conventional method (AMHI). The better growth and development of plant might be due to intensive cultivation by application of high inputs under conventional method. The recorded mean of minimum number of days taken for first flowering (29.70 days), first female flowering (34.10 days) and first harvesting (82.40 days) from days to sowing was observed in traditional conservational practices (CMLI). This might be due to conserving soil moisture can significantly improve soil quality and health in saline conditions. Moisture conservation can help mitigate the negative impacts of salinity by reducing salt accumulation and improving water availability for plants, excessive irrigation with saline water can worsen the problem. Moisture conservation practices can promote better soil structure, enhancing aeration and drainage, which can help reduce the harmful effects of salinity (Sigh et al., 2020).

Significantly mean data of (Table 1 & 2) more crop duration (132 days), number of fruits per vine (14.7), fruit weight (391.1 g), fruit yield per plant (5.77 kg) and fruits yield per hectare (96.20 t ha<sup>-1</sup>) of muskmelon was 25.16 % higher observed under conventional method (AMHI) as compared to conservation practices (71.99 t ha<sup>-1</sup>) over three years of observation. This might be due to beneficial effect of

adequate irrigation with high inputs in improving the soil environment which in turn encourages growth resulting in better absorption of moisture, nutrients and thus producing higher biomass. The results are closely associated with those reported by (Ansary and Roy 2005, Arancibia and Motsenbocker 2008, Rani et al., 2012, Anbumani et al., 2017) in melon crops. A perusal of data on gross return and net return (Table 2) revealed that higher was under conventional methods (AMHI) of cultivation (Rs. 5,28,070 ha<sup>-1</sup> and Rs. 3,48,220 ha<sup>-1</sup>) while under conservational methods (CMLI) of cultivation it was Rs. 4,68,572 ha<sup>-1</sup> and Rs. 3,39,788 ha<sup>-1</sup>. The higher yield and returns under conventional system might be attributed to good plant growth due to combined availability of soil moisture with proper nutrition and plant protection throughout the muskmelon growth period. The above results are close conformity with the various studies in other crops (Johnson et al., 2000, Rani et al., 2012, Anbumani et al., 2017).

**Relative economics for musk melon cultivation:** The conservational system (CMLI) was more profitable as compared to conventional systems (AMHI) due to significantly higher benefit cost ratio (Table 2). The mean data of B:C ratio (3.64) and net returns per day (Rs 2980 ha<sup>-1</sup>) was higher under conservational practice, while B:C ratio (2.94) and higher productivity per days (731 kg ha<sup>-1</sup>) under conventional practices. It was mainly attributed to low input cost and early maturity of the crops under conservational system as compared to conventional system. Early availability of musk melon fruit to the market fetched higher price per unit of fruits as compared to late mature crop under conventional systems resulting into higher B:C ratio

**Table 1.** Effect of conservational (CMLI) and conventional management (AMHI) on muskmelon production system

Agronomy management practices	Length of vine (m)	Number of leaves per vine	Days to first flowering (DAS)	Days to first female flowering (DAS)	Days to first harvest (DAS)	Crop duration (DAS)	Number of fruits per vine	Fruit weight (g)
CMLI	1.78	69.20	29.70	34.10	82.40	114	12.40	347.40
AMHI	2.18	80.00	35.40	40.00	91.10	132	14.70	391.10
CD (p=0.05)	0.15	4.8	1.4	1.4	2.6	2.2	0.8	17.6
C.V.	7.1	6.3	4.2	3.6	2.9	1.7	5.9	4.6

AMHI: Adequate moisture with high inputs; CMLI: Conserved moisture with low inputs; DAS: Days after sowing

**Table 2.** Effect of conservational (CMLI) and conventional management (AMHI) on muskmelon production system

Agronomy management practices	Fruit yield per vine (kg)	Fruit yield (t ha <sup>-1</sup> )	Gross returns (Rs. ha <sup>-1</sup> )	Net returns (Rs. ha <sup>-1</sup> )	B:C ratio	Productivity per days (kg ha <sup>-1</sup> )	Net returns/day (Rs. ha <sup>-1</sup> )
CMLI	4.32	71.99	468572	339788	3.64	631	2980
AMHI	5.77	96.20	528070	348220	2.94	731	2646
CD (p=0.05)	0.42	6.91	40727	NS	0.27	59	NS
C.V.	8.0	8.0	8.0	11.5	7.9	8.4	12.0

AMHI: Adequate moisture with high inputs; CMLI: Conserved moisture with low inputs; DAS: Days after sowing



**Fig. 1.** Muskmelon cultivation practices in conserve moisture

combined with low cost of inputs, muskmelon crop was early with regard to days to flowering and also days to produced early marketable fruits under conservational system as compared to conventional systems (Table 1). The increase in growth parameters, delayed flowering and fruiting under conventional systems may be attributed availability of sufficient soil moisture and inputs under irrigated conditions that enhance vegetative growth and delayed flowering (Patil et al., 2014, Anbumani et al., 2017).

### CONCLUSION

The cultivation of musk melon with indigenously developed conservational technologies in the reservoir basin of the Hemawas dam provide ensured income and livelihood to the small and marginal farmers of this area. When compared to cultivation on retained moisture in the reservoir basin, muskmelon grown conventionally, with substantial irrigation supply and adequate fertilizer inputs, reported significantly higher growth and production characteristics. This adaptation provides an insight for the formal science about how formal and informal knowledge can be hybridized to co-produce more robust adaptation to convert stressors into opportunity. The farmers having land at scattered site in the Hemawas dam which is used to store runoff water in catchment area of around 260 hectares of land. The farmer very effectively utilized the conserved soil moisture in the Hemawas dam basin for cultivation of muskmelon rather than traditional crop like wheat, barley, mustard and chickpea

which have low yield and less return. This site-specific agro-ecological adaptation gives other farmers, who are landless and generally more marginalized, additional influence.

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