Overview of Dryland Agriculture Research and Achievements in Kymore Plateau and Satpura Hills Zone of Madhya Pradesh

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Brief history of the centre

The All India Coordinated Research Project for Dryland Agriculture was started as a sub centre at Rewa in 1970-71. Later in the year 1984-85, the Centre was upgraded as main Centre. The Centre has the mandate to develop dryland agriculture technologies for Kymore Plateau and Satpura Hills zone of Madhya Pradesh with the domain districts of Rewa, Sidhi, Satna, Singrouli, Shahdol, Anooppur, Umaria, Panna, north eastern part of Katni, Jabalpur, Seoni and southern parts of Tikamgarh.

Agro-climatic zone characteristics

In general, the climate in this zone is sub-humid. Out of the total annual average rainfall of 1084 mm, the south-west monsoon contributes about 85% and post-monsoon about 15%. The normal onset of monsoon is during third week of June and normal withdrawal is during first week of October. The dry spells during crop season are experienced during August and September coinciding with flowering and grain formation stages of the major rainfed crops. The mean maximum temperature is 45.8°C (May) and the mean minimum temperature is 2.9°C (December/January).

Mean season-wise and annual rainfall and rainy days (at AICRPDA centre, Rewa)

Rainfall	Normal rainfall (mm)	Normal rainy days (No.)
South west monsoon (June-September)	965.0	40
Post-monsoon (October-December)	48.0	2
Winter (January-February)	23.3	4
Summer (March-May)	47.72	5
Annual	1084.02	51

Major soil types

The major soil types in the zone are clayey, clay loam, sandy loam and shallow to deep black soils

Major rainfed crops

The major rainfed crops cultivated in the zone during *kharif* are soybean, rice, pigeonpea, sesame, blackgram and greengram and during *rabi* are chickpea, linseed, lentil, mustard and wheat.

Dryland agriculture problems

The problems related to domain districts are as enlisted below:

Soil and land management

- Soil and water erosion
- High intensity rainfall
- Poor infiltration rate
- Multiple nutrient deficiencies
- Lack of adoption of suitable conservation measures.

Crop production related

- Low seed replacement rates
- Poor residue management
- Reduced animal power
- Unbalanced use of major nutrients and non- application of deficient micro nutrients
- Poor mechanization

Socio economic issues

- Small land holdings
- Low risk bearing capacity
- Poor adoption of technologies
- Short supply of inputs
- Market risks
- Constraints of labour availability
- Dependence on hired agricultural machinery
- Stray cattle menace

Significant achievements

Rain water management

Catchment command storage relationship studies carried out for, Khuthulia catchment, Rewa District. The highest monthly

rainfall recorded was 752.60 mm in the month of August 2016 and the highest yearly rainfall recorded was 1627.4 mm in the year 2016. In the above 10 years period, July (364.7 mm) and August (291.7 mm) months recorded maximum rainfall. The rainfall shows fluctuating nature during the ten years. The runoff for the study area is calculated using SCS- method for a period of 10 years i.e., 2008-2017. The calculated yearly runoff in mm for the years from 2008 to 2017 is 198.42, 61.38, 173.27, 415.84, 622.56, 583.84, 107.32, 219.71, 791.34 and 294.57 mm respectively. The monthly runoff and yearly runoff is calculated for the period of 10 years using SCS-CN method. Minimum runoff 61.38 mm was observed in the year 2009 and maximum runoff was 791.34 observed in the year 2016 by using SCS-CN method. The correlation coefficients for daily, monthly and yearly runoff are 0.862, 0.973 and 0.952, respectively.

The impact of life saving irrigation was 16.16% in wheat, 27.40% in chickpea, 24.54% in mustard and 19.58% in coriander when these crops were grown after rice. Wheat, chickpea, mustard and coriander were grown after soybean also showed variation in yield under control and life saving irrigation conditions. Grain yield of wheat was increased by 18.32% gram by 27.17%, mustard by 23.23% when grown after soybean.

Gabion structure were found most suitable for gully erosion control and erosion through river bank. These structures are capable for filling large cavities and deep eroded soil from the fields. It protect the field from river flood and smoothen the cavities successfully. Masonary check dam was found suitable for storing the flowing water and recycling to the surrounding fields. About 10 farmers were benefited by applying pre-sowing irrigation to 33 acres of their land. It provide assurance of growing wheat and gram.

Cropping systems

Rice + pigeonpea intercropping gave maximum seed yield of 22.85 q/ha and gross return of Rs. 12237/ha. Soybean variety JS 76 -205 black seeded gave maximum grain yield of 21.85 q/ha with 90 kg seed rate/ha. Soybean varieties gave more yield when pre monsoon sowing was done. Mixed cropping of sorghum + kodo + pigeon pea + green gram + sesamum (Line sown) proved better. Chickpea + linseed (4:2 row ration) gave the higher yield individually as well as chickpea equivalent yield (CEY) up to 10.91 q/ha . Among the pigeonpea based intercropping systems, pigeonpea + soybean (1:2) system found better. The genotype JS 81-335 is gaining popularity amongst the farmers due to its high yield and early maturity (93 days). This variety is well suited for double cropping in rainfed areas so it may be recommended for commercial cultivation in Vindhya region of Madhya Pradesh.

Nutrient management

Application of 40 kg N/ha was considered optimum for rainfed rice. On the basis of long term study (17 years) in integrated plant nutrient supply system, 100 % nitrogen through compost was superior in rice- wheat, blackgram – chickpea and rice + blackgram – wheat + chickpea sequences in terms of yield. Application of 50% N (urea) + 50% N (compost) + Azotobactor was the second best combination. Continuous application of organics helps in reducing tillage intensity and use of chemical fertilizers and improves soil environment. For the conservation of energy, low till farming strategy can be adopted in place of intensive cultivation which includes low tillage + weedicide + interculture. In a balanced nutrition study for soybean in *kharif* and chickpea in *rabi* , 20 kg N + 40 kg P with 10 kg $ZnSo_4$ / ha was found superior for soybean with yield 3114 kg/ha and B:C ratio of 4.70. In case of chickpea under residual fertility condition, maximum seed yield of 2654 kg/ha was attained in the plot where 20 kg N + 40 kg P + 10 Kg $ZnSO_4$/ha was applied to soybean in the *kharif* season.

Energy management

Bullock drawn 2-row planter was demonstrated at Rithi village of Rewa region. It was found suitable for sowing soybean, wheat and gram. It covered 20% more sowing area as compared to desi plough sowing attachment. Because of its successful performance it was widely adopted by the farmers of Rithi and surrounding villages.

Technologies developed

Rainwater management

- Ridge and furrow for *in-situ* moisture conservation
- Water harvesting and recycling from a farm pond for double cropping
- Soil and moisture conservation through vegetative barrier

Cropping systems

Intercropping systems

- Soybean + pigeonpea (4:2)
- Wheat + chickpea (2:1)
- Chickpea + linseed (4:2)

Double/triple cropping systems

- Rice-wheat
- Rice-chickpea
- Rice-lentil
- Soybean-wheat
- Soybean-chickpea

Nutrient Management

- Integrated nutrient management for rainfed crops
- Foliar spray in soybean.
- Balanced nutrition in soybean- chickpea system.

Alternate land use system

- Guava based agri-horticulture for Baghelkhand region of Madhya Pradesh

Contingency Planning

For *kharif* planning

a. Suggested contingency crops/cropping systems and cultivars under delayed onset of monsoon

Delay by 2weeks (4th week of June)

- Rice-upland (JR-201, Danteswari);
- Soybean (JS20-69, JS20-98, JS20-119,);
- Pigeonpea (TJT501, Rajeshwari, Asha)
- Greengram (TJM3, PDM-139, Shikha);
- Blackgram(IPU 2-43, Indira urd-1, PU-35)

Delay by 4 weeks (2nd week of July)

- Rice-upland (JR-201, Danteswari); soybean (JS20-34, JS20-98); pigeonpea (TJT501, Rajeshwari, Asha); greengram (TJM3, PDM-139, Shikha); blackgram (IPU 2-43, Indira urid-1, PU-35)

Delay by 6 weeks (4th week of July)

- Sowing of alternate crops sesame, blackgram, greengram
- Intercropping of pigeonpea + Greengram/ Blackgram (2 : 4)

Delay by 8 weeks (2nd week of August)

- Prefer, greengram, blackgram crops with suitable short duration varieties
- Intercropping of greengram, blackgram, and sesame with pigeonpea

b. Crop, soil, water and nutrient management strategies during seasonal drought

Early season drought

- Gap filling
- Resowing with short duration varieties
- Weeding and use of weeds as mulch between row of crops
- Use of blade harrow for moisture conservation
- Prefer intercropping of greengram, blackgram, and sesame with pigeonpea
- Prefer intercropping of chickpea with linseed

Mid-season drought

- Provide life saving irrigation, if available
- Frequent interculture operations like hoeing and weeding.
- Ridges are made after 15 to 20 lines of crops for the moisture conservation.
- Interculture with *doura/kulpha*/hand hoe in between rows and use removed weeds as mulch for moisture conservation.

Terminal drought

- Apply light irrigation to *kharif* crops for proper grain filling if required; this will also be helpful in field preparation for *rabi* crops.
- Foliar spray of 1% soluble NPK (19:19:19)
- Prefer sowing of lentil, linseed, chickpea, etc during *rabi* season

Agri-horti systems

- Guava + soybean/rainfed wheat/chickpea/linseed/lentil

Technologies upscaled in convergence with various programmes

The dryland technologies are being upscaled through department of agriculture, department of horticulture, KVKs, ATMA, etc.

Impact of technologies

Rainwater management

The impact of life saving irrigation was 16.16% in wheat, 27.40% in chickpea, 24.54% in mustard and 19.58% in coriander when these crops were grown after rice. Wheat, chickpea, mustard and coriander were grown after soybean also showed increased in yield with supplemental irrigation i.e. wheat yield by 18.32% , chickpea by 27.17%, mustard by 23.23%. Soybean with broad bed and furrow system enhanced yield along with the improved physical property of soil, root development and water use efficiency. Soybean, pigeonpea, blackgram, greengram and sesame are sown on ridges with the help of tractor drawn ridge and furrow planter. The ridges are formed 45 cm apart and 15 cm wide on top. The technology of ridge and furrow conserves 45% more moisture than flat bed sowing and retains it for a longer period. It increases the crop yield by 40-45% than farmers practice. Masonry check dam was found suitable for storing the flowing water and recycling to the surrounding fields. About 10 farmers were benefited by applying pre-sowing irrigation to 33 acres of their land.

Cropping systems

Soybean + pigeon pea system (3:2) gave net returns of Rs 38100/ha. This system performs better in low rainfall region. The farmers are practicing this system in Rewa region in considerable area. Wheat + mustard (2:1) intercropping system gave wheat equivalent yield of 3010 kg/ha (2017 kg/ha of wheat + 386 kg/ha of mustard) and farmers are practicing this system in Rewa region in considerable area.

Planting of vetiver grass on field bunds will reduce soil loss by erosion and holds moisture for longer period two facilitate crop to survive in dry periods. Adoption of vetivar grass as live bunds in fields will reduce the soil loss and run off in the slope up to 2%, live barrier of khus grass reduce runoff and soil loss as compared to control which results in higher soil loss.

The land equivalent ratio (LER) of all the intercropping systems studied ranged from 1.32 to 1.65 indicating yield advantage with pigeonpea based intercropping systems. The maximum LER of 1.65 was recorded with pigeonpea + soybean (1:2) intercropping system followed by pigeonpea + greengram system (1.64).

Inter cropping of chickpea and coriander, both being important crops are readily accepted by the cultivators. And this system is spread to more than 40% in watershed area.

Way forward

The sustainable dryland agriculture calls for development of land and water resources in watershed approach. There is need to identify water-productive cropping systems and under-exploited crop and enhance abiotic stress tolerance of important dryland crops through conventional physiological approaches. The future research should focus on strategies for crop diversification, promoting nutrient and water use efficiency, improving and sustaining soil quality in rainfed agro-eco-regions, crop and management practices and delineation of risk-prone zones, strategies for promoting balanced fertilization through site specific and integrated nutrient management and enhancing nutrient and water use efficiency through precision farming and development of integrated farming systems models.