Doable Agriculture Technologies under Rainfed Conditions in Kandi Region of Punjab

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Citation:

S.C. Sharma, Vijay Kumar, Vivek Sharma, Anil Khokhar, G. Ravindra Chary & Manmohanjit Singh (2015). Doable Agriculture Technologies under Rainfed Conditions in Kandi Region of Punjab All India Coordinated Research Project for Dryland Agriculture, Regional Research Station, Ballowal Saunkhri (Punjab Agricultural University) Ballowal Saunkhri, Distt. S B S Nagar, Punjab - 144 521

Sponsored by:

All India Co -ordinated Research Project for Dryland Agriculture
National Initiative on Climate Resilient Agriculture
Central Research Institute for Dryland Agriculture
Hyderabad, Andhra Pradesh - 500 059

First Edition: December, 2015

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Foreward

In Punjab rainfed area lies in North-Eastern part in the form of 10 to 20 km wide strip known as '*Kandi*' area. The area of region is approx. 3.93 lakh hectares which comprises approximately 7.8 per cent of total geographical area of the State. The crop production in rainfed area is mostly dependent on rainfall received during the monsoon season. The productivity of rainfed crops remains low which is attributed to erratic distribution of rainfall, intermittent dry spells during the crop season, delayed onset and early withdrawal of monsoon.

In order to address the problems of region and develop need based location specific rainfed technologies for sustainable agriculture in the area, All India Coordinated Research Project for Dryland Agriculture (AICRPDA) at Ballowal Saunkhri was started in Hoshiarpur during 1970. This centre has addressed the various issues pertaining to dryland agriculture of the region by conducting experiments (both at station and on-farm) and developing new technologies in the field of Rainwater management, **Crops & Cropping systems,** Integrated nutrient management, Energy management, Evaluation of improved varieties, Alternate land use and Integrated farming system. A brief account of each technology has been included describing the target domain, technology and its performance and means of up-scaling the technologies developed to minimize the risk in dryland agriculture.

I appreciate the efforts of the AICRPDA, Ballowal Saunkhri scientists for documenting the technologies and experiences in the form of bulletin **"Doable Agriculture Technologies under Rainfed Conditions in Kandi Region of Punjab"**. I hope the document will serve as a guide to all the stakeholders involved in development and implementation of rainfed technologies.

November, 2015
Ludhiana

Dr Balwinder Singh
Director of Research

Acknowledgment

All India Coordinated Research Project for Dryland Agriculture (AICRPDA) was initiated in 1970 at PAU, Ludhiana campus and shifted to Ballowal Saunkhri in1990 along with an Operational Research Project on watershed approach. The project has successfully conducted several experiments since its inception to generate location specific technologies through on-station research focusing rainwater management, soil & water conservation, integrated nutrient management (INM), cropping systems, crop improvement, energy management, alternate land use and farming systems under rainfed maize-based production system of *Kandi* region of Punjab.

The authors/editors express their profound gratitude to Dr. B.S. Dhillon, Honorable Vice Chancellor, Dr. S.S. Gosal former Director of Research, Dr. Balwinder Singh, Director of Research, Dr. R. S. Sidhu, Director of Extension Education, Punjab Agricultural University, Ludhiana, for continuous encouragement, thought provoking suggestions, providing necessary facilities, administrative support in bringing out this publication. We are also grateful to Dr. A.K. Sikka, Deputy Director General (NRM), ICAR, New Delhi, Dr. B. Venkateshwarlu and Dr. Ch. Srinivasa Rao, former and present Directors, CRIDA, Dr. G. Ravindra Chary, Project Coordinator, AICRP for Dryland Agriculture and other team members at CRIDA, Hydrabad for financial support, guidance, valuable suggestions in planning and execution of experiments.

Finally, we sincerely thank Directors, scientists & supporting staff of Regional Research Station, Ballowal Saunkhri for providing assistance in planning and execution of experiments since inception of this project. We are also thankful for the co-operation and support received directly or indirectly from former Chief Scientists, scientists and supporting staff in preparation/documentation in time.

November, 2015
Ballowal Saunkhri

EDITORS

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Maize hybrids for higher productivity under rainfed conditions in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers grow maize (local) as major *kharif* crop in this region of Punjab with local cultivars, which are prone to lodging due to higher placement of cob from the ground level. These are sensitive to mid and late se ason droughts resulting in low productivity and net returns. Some farmers grow hybrids recommended for irrigated conditions which are very poor yielders in rainfed conditions and stalk rot is also a problem in these hybrids.

Improved Technology

This involves replacement of local maize with hybrids namely PMH 2 and Prakash. These hybrids are medium in height with medium cob placement from ground level, tolerant to lodging, mid and late season drought. Their average yield potential is 4125 kg/ha (PMH 2) & 3125 kg/ha (Prakash) with attractive orange flint grains, which fetch good price in the market. These hybrids give higher yield when sown early with the onset of monsoon from 20th June to 7th July.

The key management practices include optimum spacing (40-50 cm between rows and 20-25 cm between plants), seed treatment with fungicide, drilling 40 kg N and 40 kg P_2O_5/ha as basal dose and broadcasting 40 kg N/ha at knee height stage just before earthing up and weed control by spraying Atrazine @ 1.25 kg/ ha in 500 litre of water as pre emergence herbicide within 2 days of sowing.

Local cultivar

Maize hybrid PMH 2

Performance

Maize hybrids yield 3000 -3500 kg/ha under rainfed conditions, which is 80 - 90% higher than local (1450 kg/ha). The net returns with hybrids are up to Rs. 40,000/ha. Further, these hybrids can be harvested almost two week in advance at physiological maturity, thus leaving more residual moisture for the subsequent *rabi* crops.

Impact and Upscaling

Maize hybrids are grown by about 50 per cent farmers in domain district of *Kandi* region. Further extension efforts through front line demonstrations and other government schemes like ISOPOM can push this technology to other farmers.

Improved variety of Pearl Millet (Fodder) for Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Dairy farming is main occupation of the farmers in this region. Availability of good quality fodder is less during the lean periods due to high demand. The farmers grow local cultivars of pearl millet (fodder) having low fodder productivity.

Improved Technology

Involves cultivation of high yielding variety and improved management practices. Variety FBC 16 is exclusively for fodder production. It flowers 8-10 days later than other varieties including local thus, provides green fodder for longer period. This variety has long and broad leaves which remain green till maturity and comparatively resistant to major diseases. This variety has high dry matter intake, contains low amount of oxalates with stable yield under stress conditions.

Local cultivar

Improved variety FBC-16

Performance

FBC 16 gives average yield of 35000-40000 kg/ha fodder yield which is almost double than the local cultivars even under low rainfall conditions.

Impact and Upscaling

The area under FBC 16 is increasing in *Kandi* area and presently covers about 20 % of the total area under pearl millet (fodder) in Shahid Bhagat Singh Nagar and Hoshiarpur districts. Further extension efforts through FLDs, NFSM, ATMA, RKVY and other government schemes can popularize this variety among farming community.

Improved variety of chickpea for Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers grow local cultivars of chickpea in *Kandi* region which are affected by dry spells and also susceptible to blight. This coupled with poor crop management practices results in low yields.

Improved Technology

Involves cultivation of superior variety and improved management practices. Variety PBG-1 and PBG -5 are resistant to blight, wilt complex and tolerant to drought with a yield potential of 1600-1700 kg per hectare and maturing in160 -165 days. Other improved practices to be adopted are seed treatment with fungicides, sowing at 12.5 cm depth with seed drill, basal application of 13 kg N and 20 kg P_20_5 per hectare and controlling pod borer by need based spray of Deltamathrin 2.8 EC @ 2ml/l water.

Performance

The improved technology gives higher seed yield (up to 1200 kg/ha) with B:C ratio of 2.19 . The yield advantage is 72 % as compared to local cultivar (700 kg/ha).

Chickpea Local

Chickpea – PBG 5

Impact and upscaling

The area under PBG 1 and PBG 5 is increasing in *Kandi* region and presently covers 12 per cent area in Shahid Bhagat Singh Nagar and Hoshiarpur districts. Further extension efforts through FLDs, NFSM, ISOPOM, other governmental schemes and KVK's extension efforts can push this technology in farmers' fields.

Improved rainfed varieties of wheat (PBW 644 & PBW 660) for Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers are growing old wheat variety PBW 175 in *Kandi* region having average productivity of 3125 kg/ha.

Improved Technology

Involves cultivation of superior variety and improved management practices. Wheat variety PBW 660and PBW 644 are exclusively for cultivation under rainfed conditions and take about 162 and 159 days to mature, respectively. Grains are amber, hard, medium bold and lustrous with excellent chapati quality. PBW 660 is resistant to yellow and brown rust and less susceptible to Karnal bunt and loose smut diseases, while PBW 644 is less susceptible to yellow rust, moderately resistant to brown rust.

PBW 660

PBW 644

Performance

Wheat variety PBW 660 and PBW 644 gives average grain yield of 4275 and 4100 kg/ha, respectively which is 37 & 31 per cent higher than old variety PBW 175.

Impact and Upscaling

The area under PBW 660 and PBW 644 is increasing in *Kandi* region and presently these varieties cover about 10 % of the total area under rainfed wheat in Shahid Bhagat Singh Nagar, Roopnagar and Hoshiarpur districts. Further extension efforts through FLDs, NFSM, ATMA, RKVY and other government schemes can popularize these varieties among farmers.

Improved varieties of Oilseed crops for rainfed situations

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

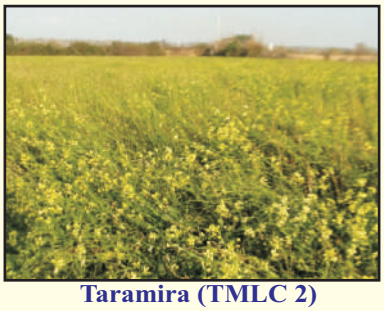
Existing Practice

Farmers grow local varieties of sesame, linseed, raya and taramira. These varieties are having low yield potential and susceptible to biotic and abiotic stresses.

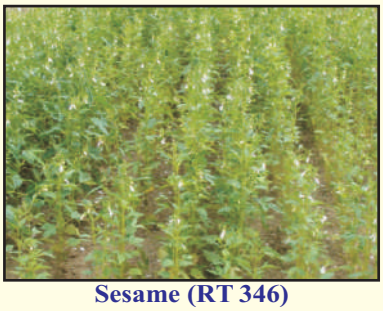
Improved Technology

Improved high yielding varieties of sesame, linseed, raya and taramira are recommended for cultivation under rainfed conditions as given below:

Crop	Variety	Average Yield (kg/ha)	Special characters
Sesame	Punjab Til No. 2	700	Profuse branching and dense pod bearing with white and bold seeds having 49% oil content.
	RT 346	675	White bold seeds and 49 per cent oil content
Linseed	LC 2063	1230	Lustrous brown seeds and 38.4 per cent oil content.
Raya	RLM 619	2000	Bold seeded having 43% oil content and greater resistance to white rust, downy mildew and alternaria blight.
Raya	PBR 97	1300	Medium bold grains having 39.8% oil content.
Taramira	TMLC 2	725	Suitable to animal damage prone areas.



Taramira (TMLC 2)



Sesame (RT 346)

Performance

These improved varieties are high yielding. Raya varieties are suitable for intercropping in wheat. Sesame and taramira varieties can be grown in animal damage prone areas as they are comparatively less damaged by the animals in comparison to maize and wheat.

Impact and Upscaling

Area under the oilseed crops in *Kandi* region is increasing due to less water requirement in comparison to traditional crops like maize and wheat. Further extension efforts through FLDs by state agriculture department and KVKs can increase the area under these crops/varieties.

Improved varieties of Pulses for rainfed situations

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Majority of farmers grow local varieties of greengram, blackgram and lentil. These varieties are having low yield potential and susceptible to biotic and abiotic stresses.

Improved Technology

Improved high yielding varieties of greengram, blackgram and lentil recommended by Punjab Agricultural University, Ludhiana for cultivation under rainfed conditions are given below:

Crop	Variety	Average Yield (kg/ha)	Special characters
Greengram	PAU 911	1225	Fairly resistant to mungbean yellow mosaic virus (MYMV), cercospora leaf spot (CLS) and bacterial leaf spot (BLS)
Greengram	ML 818	1225	Moderate degree of resistance to mungbean yellow mosaic virus and good resistance to cercospora leaf spot and bacterial leaf spot diseases. It is also tolerant to whitefly.
Blackgram	Mash 114	900	Resistant to yellow mosaic virus, bacterial leaf spot and cercospora leaf spot diseases
Lentil	LL931	1200	Fairly resistant to rust and good tolerance to pod borer
Lentil	LL699	1250	Moderately resistant to rust and blight diseases and good tolerance to pod borer

Greengram (PAU 911)

Lentil (LL931)

Performance

The sowing of greengram and blackgram in the first fortnight of July gives higher yield and good for intercropping with maize as they are determinate in height and synchronous in maturity. Lentil varieties perform well on marginal lands and under moisture stress due to low water requirements.

Impact and Upscaling

Area under the pulse crops in *Kandi* region is less due to susceptibility of local cultivars to biotic and abiotic stresses. So, extension efforts through FLDs by State agriculture department and KVKs can increase the area under these crops/varieties.

Maize + greengram (2:1) intercropping system for higher productivity in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Maize is predominantly cultivated as sole crop under rainfed conditions in the *Kandi* region of Punjab and the farmers in general do not cultivate any intercrop in maize in this region. Maize crop is prone to risk of mid and late season drought resulting in low yield. Cultivation of sole crop under such conditions is not profitable especially under severe drought conditions

Improved Technology

The technology includes intercropping of one row of green gram in paired rows of maize (30 x 60 cm). The seed rate of maize and greengram is 20 kg/ha and 5 kg/ha, respectively and the fertilizer dose is 80:40:20 kg NPK/ha and 10 kg P_2O_5 for maize and greengram, respectively.

Maize + greengram (2:1) Intercropping system

Performance

Intercropping of greengram (one row) with paired rows of maize gives higher Maize Equivalent Yield of 3153 kg/ha which is 16% higher than sole maize. The improved technology also gives additional income of Rs. 1443/ha over sole maize.

Impact and Upscaling

The technology of paired row intercropping in maize is new to farmers of the domain area and can be upscaled through demonstrations by line departments and KVKs

Wheat + Raya (12:1) intercropping system for higher productivity in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers generally grow wheat and raya as sole crop. In some areas, raya is also grown as intercrop at a spacing of 1.5 m between two rows of Raya. These practices produce lower yields of both the crops.

Improved Technology

In wheat and raya (2:1) intercropping system, wheat is sown @ 100 kg seed /ha, row spacing of 25 / 30 cm from end October to 15th November after seed treatment with chloropyriphos (4 ml per kg seed) for the control of termite. It is required to drill 40 kg N and 40 kg P_2O_5/ha as basal dose and broadcast 40 kg N ha at the receipt of winter rains. Raya is sown in rows, 3m apart with seed drill immediately after the completion of wheat sowing. No additional fertilizer dose is applied to raya rows.

Traditional Wheat + Raya intercropping (1:1)

Improved wheat + Raya intercropping (12:1)

Performance

Additional net return of about Rs. 1000/ha is realized due to 12:1 system of raya at 3 m as compared to sole wheat. This system also covers the risk of crop failure during drought due to wide spacing and less competition for soil moisture.

Impact and Upscaling

The area under 12:1 wide row system is increasing in *Kandi* region and presently covers 38 per cent wheat area in adopted villages of Shahid Bhagat Singh Nagar and Hoshiarpur district. Further extension efforts through FLDs, NFSM, ISOPOM and other governmental schemes can push this technology in farmers' fields

Toria + Gobhi sarson (1:1) intercropping system for better returns in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers mainly grow wheat during *rabi* in *Kandi* region of Punjab. After harvesting maize in last week of September, residual soil moisture continues to reduce till the sowing of wheat in the last week of October. Sowing wheat on moisture deficit seed zone (upper soil layer dries up due to early withdrawal of monsoon) leads to poor crop stand and low production.

Improved Technology

The improved technology involves sowing of gobhi sarson and toria (1:1) intercropping immediately after harvest of maize crop in the last week of September to utilize the residual soil moisture efficiently. The gobhi sarson variety (GSC 7) and toria variety (TL 17) is sown simultaneously in alternate rows 22.5 cm apart with seed rate of 2.5 kg/ha per crop by pora method. Other management practices involves the basal application of 40 kg N and 20 kg P_2O_5/ha and thinning after 3 weeks of sowing. The benefit of this system is that growth of toria occurs in the month of November ,whereas gobhi sarson remains dormant till end December and toria crop is harvested in the month of December. The already established but dormant gobhi sarson resumes its growth in the second fortnight of January. The gobhi sarson is harvested in end march, thus there is lesser competition for growth and soil moisture between these crops.

Performance

Intercropping of toria + gobhi sarson (1:1) gives seed yield of 480 kg/ha of toria and 1100 kg/ha yield of gobhi sarson with additional income of Rs 7800/ha as compared to sole gobhi sarson and Rs. 5210/ha over sole toria cultivation. The main advantage of this system is that both the crops require less soil moisture for growth in comparison to wheat and intercropping of toria + gobhi sarson, are profitable even during drought years.

Sole toria

Toria and Gobhi sarson intercropping

Impact and Upscaling

The area under toria+gobhi sarson (1:1) intercropping system is 15-20 percent in adopted villages of SBS Nagar and Hoshiarpur districts of *Kandi* region. Further extension efforts through FLDs by KVKs and other government schemes can popularize this system among farmers.

Application of thiourea to wheat under dryland conditions

Recommendation Domain

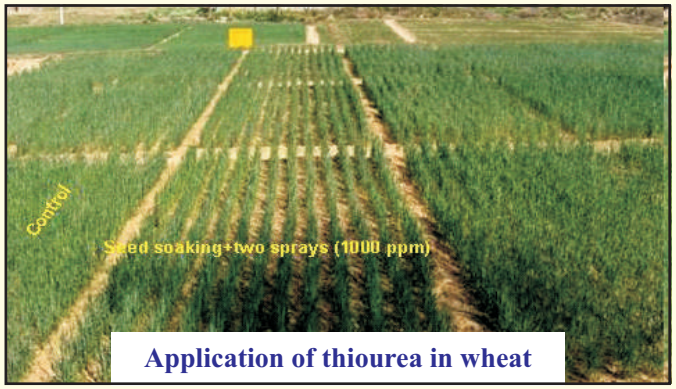
Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers go for the sowing of wheat crop with residual seed moisture under rainfed conditions. Availability of low soil moisture at the time of sowing results in poor germination and crop stand. In addition to this, terminal heat coupled with moisture stress during the reproductive stage severely affects the grain yield.

Improved Technology

Seed soaking of 100 kg seed with 150 gm thiourea dissolved in 150 litre water (1000 ppm thiourea) 6 hours before sowing and sowing with seed drill by pora method improves the germination and ultimately crop stand. Two sprays of thiourea @ 200 gm in 200 litres of water helps in mitigation of the rise in temperature at the time of grain filling stage.



Application of thiourea in wheat

Performance

Seed soaking with 1000 ppm thiourea and two sprays with 1000 ppm thiourea (one at maximum tillering & other at booting stage) to wheat crop gives grain yield of 2166 kg/ha which is 20% higher than farmers practice.

Impact and Upscaling

The technology of thiourea application to wheat is new to the farmers of the domain area and can be upscaled through demonstrations by line departments and KVKs.

Seed priming of chickpea with molybdenum under rainfed conditions

Recommendation Domain

Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers do not practice any kind of seed priming.

Improved Technology

Seed priming is a simple, low-cost, low-risk technology that hastens germination and seedling emergence and promotes vigorous early growth so that soil moisture, nutrients, etc. are captured and utilised. Seed priming simply involves soaking seeds in water , usually 'overnight', surface-drying them and then sowing.

Soaking of 45 kg chickpea seed in 92.5 g ammonoium molybdate (54 % Mo) [$(NH_4)_6 Mo_7O_{24}.4H_2O$] dissolved in 100 liters of water (500 ppm) for six hours before sowing results in higher yield, net returns and benefit:cost ratio under rainfed conditions. Seed priming with molybdenum @ 0.5g/l ensures uniform germination and good seedling vigour.

Seed priming with molybdenum @ 0.5 g/liter

Performance

Seed priming with Mo @ 0.5 g/l solution gave grain yield of 1290 kg/ha which was 15.7 per cent higher over control (1087 kg/ha).

Impact and Upscaling

Seed priming with molybdenum @ 0.5g/l is new technology for the farmers of the domain region and can be upscaled through demonstrations by line departments and KVKs.

Application of phosphorus, sulphur & seed inoculation with Rhizobium to chickpea under dryland conditions

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

The chickpea is generally grown by farmers on light soils and they only apply N as basal dose. This is the main cause of the low productivity of chickpea in the region.

Improved Technology

The seed inoculation of chickpea with *Rhizobium* culture is done just before sowing of crop. The fertilizers i.e. 20 kg sulphur, 30 kg $P_2O_5$and 15 Kg N per hectare are applied as basal dose and inoculated seed is sown with plough by pora method at a row spacing of 30 cm. Being a legume crop, chickpea responds well to sulphur and bio fertilizers. Sulphur plays an important role in the formation of sulphur containing essential amino acids (cysteine, methionine and cystine), synthesis of proteins and promotion of nodulation. The application of bio -fertilizers is cheap, essential for enhancing microbial activity which improves soil health and ultimately crop yield.

Application of P + S in chickpea

Performance

Chickpea gives higher seed yield of 1134 kg/ha when 30 kg P_2O_5 + 20 kg S ha^{-1} ($P_{30}S_{20}$) is applied along with seed inoculation with *Rhizobium* and yields 20 – 30 per cent higher than farmers practice. This technology gives an additional income Rs. 5619/ha with B:C ratio of 2.49

Impact and Upscaling

The technology of phosphorus, sulphur and bio -fertilizer application to chickpea is new to farmers of the domain area and can be upscaled through demonstrations by line departments and KVKs.

Integrated nitrogen management practices in maize/blackgram wheat/lentil cropping system under dryland conditions

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

The Farmers of region are using mostly FYM to raise the crops and very less inorganic fertilizers i.e. they do not integrate organic and inorganic sources of nitrogen. During *rabi* season farmers hardly apply organic sources of nitrogen.

Improved Technology

The improved technology involves the integrated nitrogen management i.e. combination of organic (compost or green leaves) and inorganic (urea) sources of nitrogen in different proportions. For maize/blackgram-wheat/lentil cropping system 15 kg N/ha through compost/green leaves (organic) + 20 kg N/ha through urea (inorganic) help in sustaining the productivity levelbesides improving soil health. The organic sources of nitrogen are applied before sowing while the half of inorganic nitrogen is applied at the time of sowing and remaining half at knee height stage in maize and after receiving winter rains in wheat.

Maize/blackgram

Wheat/lentil

Performance

The integrated application of nitrogen performs better compared to sole application of organic or inorganic sources. The 15 kg N/ha (compost/green leaves)+ 20 kg N/ha (urea) treatment in maize/blackgram and wheat/lentil gives higher crop yield and net returns as compared to application of either sole organic or inorganic source of nitrogen.

Impact and Upscaling

The farmers of the region are integrating organic and inorganic sources of N fertilizers to some extent but the proper integration of these sources can be upscaled through trainings/demonstrations by line departments and KVKs

Sesame (Sesamum indicum L.) a profitable alternate crop under delayed monsoon in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

The normal onset of south – west monsoon rains in *Kandi* region is last week of June. Maize is the dominant *kharif* crop in the region. The farmers cultivate maize even under delayed monsoon conditions i.e. even after 15 th July, resulting in poor performance of crop and reduction in yield.

Improved Technology

Sesame (*Sesamum indicum* L.) is an alternate crop for maize under delayed onset of South West monsoons. Sesame is drought tolerant crop and water requirement of this crop is low compared to maize. The seed rate of sesame is 2.5 kg/ha and var. RT 346 is sown with seed drill by pora method at 3 -4 cm deep or by broadcasting followed by light planking. Nitrogen is applied as basal @ 35 kg/ha.

Performance

Sesame var. RT 346 gives average yield of 450 kg/ha with net return of Rs. 34,000 due to higher market price. Another advantage is that sesame crop sown under late conditions i.e. in the third week of July is also less affected by phyllody.

Sesame under timely sown condition

Sesame under late sown condition

Impact and Upscaling

The area under sesame is less than 1 per cent in domain area, farmers are now shifting from maize/rice due to less cost of cultivation and less incidence of phyllody in the late sown conditions. The extension efforts through FLDs by state agriculture department as well as KVKs, can promote the cultivation of this crop.

Contingency crop planning for light textured soils in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

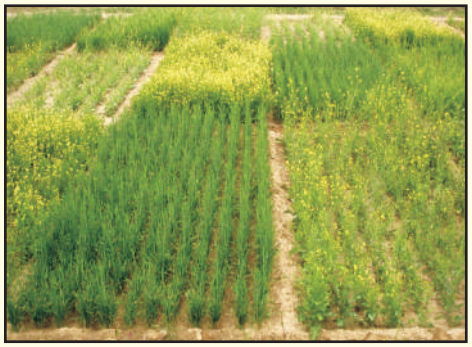
Existing Practice

The farmers of domain area are growing maize and wheat irrespective of time of onset, withdrawal and extent of south west monsoon rains. The rains are main source of water/moisture for crops during both seasons and water requirement of both crops is higher than some oilseeds and pulses. This is the main reason for low productivity in this area.

Improved Technology

The improved technology involves the sowing of different crops with the onset of South West monsoon rains. For timely onset of monsoon the preference of *kharif* crops should be maize, blackgram, pearl millet (grain), pearl millet (fodder), sesame and greengram. If sesame crop is to be grown, it can be sown after 15 th July. For late sowing, the preference of *kharif* crops should be pearl millet (grain), blackgram, maize (fodder), pearl millet (fodder), greengram and sesame. For timely sowing of *rabi* crops under low moisture conditions due to early withdrawal of monsoon and no winter rains, taramira crop should be preferred. For late sowing of *rabi* crops under low moisture conditions crops like taramira, lentil and raya are to be preferred compared to wheat, barley and triticale.

***Kharif* season**



***Rabi* season**

Performance

In case of late onset of monsoon, blackgram, sesame and pearl millet (fodder) crop in *kharif* season, while taramira and lentil in *rabi* season (low soil moisture conditions) are economical due to low water requirement of these crops compared to maize and wheat.

Impact and Upscaling

The technology of cultivation of the crops according to onset and extent of south west monsoon is new to farmers of the domain area and can be upscaled through trainings/demonstrations by line departments and KVKs .

Groundnut as an alternative crop to maize in lower Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers in lower *Kandi* region grow maize in *kharif*. However, erratic rainfall, frequent dry spells and high susceptibility of maize to early and mid-season droughts results in unstable and low yields, particularly when grown on sandy soils overlying loamy sub soils.

Improved Technology

Groundnut is an alternative crop to maize in lower *Kandi* region. Groundnut can be sown from mid June to first week of July with the onset of monsoon. Unlike maize, it tolerates early drought, improves soil health and acts as cover crop for soil conservation. Improved bunch type groundnut variety SG -99 matures in 123 days with yield potential of 2000 kg/ha. Since pods are borne as bunch around the shoot, it allows easy harvesting with minimum pod loss. The other improved practices to be adopted for getting higher pod yield are sowing with 100 kg seed /ha after treating with Chlorpyriphos 20EC (12.5 ml/kg seed) followed by Indofil M-45 (3g/kg seed) to safeguard against termite and fungal diseases The spacing is 30 cm between rows and 15 cm in the row. Application of gypsum @ 125 kg/ha and drill the recommended fertilizer dose i.e. 15 kg N, 20 kg P_2O_5 as basal. Two hoeings are needed after 2-3 and 5 weeks of sowing for controlling weeds. The crop is harvested in the 4th week of October.

Maize subject to water stress

A healthy crop of Groundnut Variety SG - 99 in farmer's field

Performance

Groundnut yields about 1600 kg/ha and net returns of Rs 25,000 per hectare with B: C ratio of 1.75 as compared to groundnut equivalent yield of 500 kg/ha with (1500 kg/ha) with net returns of Rs 3600 per hectare and B:C ratio of 1.20 in case of maize. Another added advantage is that groundnut performs better during early drought as compared to maize.

Impact and upscaling

Groundnut is cultivated by some farmers in adopted villages in Shahid Bhagat Singh Nagar and Hoshiarpur districts of *Kandi* region. Further e xtension efforts through FLDs, NFSM, ISOPOM and other governmental schemes can push this technology in farmers' fields.

Taramira-A profitable crop in wild/stray cattle menace prone areas for Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers in the region generally grow local taramira cultivar as a guard crop around wheat or as mixed crop in pulses in upper *Kandi* and also as sole/intercrop in lower *Kandi* region. The yield is low as farmers use local varieties with poor management. Farmers are aware of its value as guard crop against wild animals but its potential is not fully exploited as main crop.

Improved Technology

This involves growing improved varieties of taramira as a main crop to realize good income and also avoid the menace of wild animals due to bitter taste and pungent smell. TMLC 2 is drought tolerant variety with a yield potential of 770 kg/ha and matures in 150 days. This variety is least damaged by wild animals and can be sown in October after harvest of *kharif* crops. Other improved recommended practices are sowing either by *kera* or *pora* with seed rate of 3.75 kg ha and row spacing of 30 cm, basal application of 30 kg N/ha, thinning at 21 and weeding operations 30 days after sowing and controlling *Alternaria* blight by spraying copper fungicides.

Taramira as guard crop

Taramira as main crop

Performance

Taramira cv. TMLC2 gives seed yield of 770 kg per hectare with net return of Rs 13,500 and B:C ratio of 3.39. Major advantage with this crop is pungent smell and bitter taste that keep away wild and stray animals from fields.

Impact and Upscaling

Area under taramira crop is increasing in *Kandi* region due to availability of high yielding variety and least damage by animals. Some of the wheat growing farmers in Shahid Bhagat Singh and Hoshiarpur districts of *Kandi* region are growing it as main crop in animal damage prone areas. Further upscaling can be done through extension efforts by line departments and KVKs.

Sesame (Sesamum indicum L.)-Alternate crop for maize during kharif season in wild/straycattle menace prone areas

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Maize is dominant *kharif* crop in the *Kandi* region of Punjab but wild/stray cattle menace is becoming a major threat to maize in this region.

Improved Technology

Sesame (*Sesamum indicum* L.) is alternate crop for maize in the region where other crops are damaged by wild/stray cattle, sesame is least damaged.

Maize crop damaged by stray animals

Sesame crop under similar situation

Performance

Sesame is drought tolerant crop and is less damaged by the wild/stray animals compared to maize. The seed rate of sesame is 2.5 kg/ha and var. RT 346 is sown with seed drill by pora method at 3-4 cm deep or by broadcasting followed by light planking. Nitrogen is applied as basal dose @ 35 kg/ha.

Impact and Upscaling

The area under sesame is less than 1 per cent in region, the farmers are now shifting from maize/rice due to low cost of cultivation and higher returns besides less damage by wild/stray cattle. The extension efforts through FLDs by state agriculture department as well as KVKs, can promote the cultivation of this crop.

Reduced tillage formaize-wheat cropping system under rainfed conditions

Recommendation Domain

Shahid Bhagat Singh Nagar , Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers are cultivating their fields 4-5 times before the sowing of the crop. This practice is increasing their cost of cultivation and also leads to wastage of resources and energy.

Improved Technology

The improved technology involves one summer ploughing after the harvesting of *rabi* crops and receiving sufficient rains, then fields are prepared by one ploughing + planking for sowing of *kharif* crops. For *rabi* season, immediately after harvesting of *kharif* crops the fields are ploughed once (in evening) followed by planking (in next morning) to conserve the soil moisture. Depending upon the sowing time of *rabi* crops, the field are prepared by one ploughing and planking followed by sowing with seed drill.

Maize

Wheat

Performance

Reduced tillage gives the grain yield at par with conventional tillage (farmer's practice). It reduced the cost of cultivation by Rs. 3000/ha only by reducing the number of ploughings required to prepare the fields for sowing of the crops.

Impact and Upscaling

The technology of reduced tillage/cultivation of the crops is new to farmers of the domain area and can be upscaled through trainings/demonstrationsby line departments and KVKs.

Tractor operated seed-cum-fertilizer drill for higher productivity of wheat in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers mainly grow wheat during *rabi* in *Kandi* region of Punjab. Delay in rainfall, shortage of bullock draft power, inadequate moisture seed zone, use of local seed drill are some of the reasons for poor yields in wheat.

Improved Technology

This involves use of tractor - operated seed cum fertilizer drill. It is developed with modified furrow openers and zero till - drill. This drill can sow 4 ha/day resulting in 75 percent of time saving. The implement places seed in moist zone without placing soil over the seed. It also places fertilizer at optimum depth. Sowing with this seed drill results in better crop stand. Wheat (PBW 644) can be sown @ 100 kg seed /ha with row spacing of 25 / 30 cm from end October to 15th November. The cost of operation is Rs.750/ha.

Performance

Wheat sowing with seed drill gives 3250 kg of grain yield/ha, net returns of Rs 17648 per hectare with B:C ratio of 2.69 as compared to 1958 kg grain, Rs 11518 net returns and a B:C ratio of 2.00 with wooden plough.

Seed drill sown **Wooden plough sown**

Impact and Upscaling

About 50 per cent farmers in adopted village of Shahid Bhagat Singh Nagar and Hoshiarpur districts currently use this seed cum fertilizer drill. Large scale adoption can be achieved by more demonstrations by KVKs and line departments.

Wheel Hand Hoe for efficient weeding for rainfed crops in Kandi region of Punjab

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Farmers do weeding manually and use khurpi/sickle in different crops. This method of weeding is time consuming and uneconomical which results in poor crop yield.

Improved Technology

The improved technology involves the use of wheel hand hoe for the weeding operations in different crops. The weeding is generally done 30 to 35 days after sowing. It takes 3 mandays/ha for weeding with wheel hoe in comparison to 25 -30 days with manual weeding and also provides soil mulch which reduces moisture losses. More over availability of labour is problem in this region.

Wheel Hand hoe

Performance

The use of wheel hand hoe increased the crop yield of *kharif* and *rabi* crops by 5-10 per cent over traditional method of weeding. The weeding with wheel hoe reduced the required drastically about 20 mandays which saving Rs. 5000/ha.

Impact and Upscaling

This technology has spread to about 20 per cent of the farmers in *Kandi* region of Punjab. With further extension efforts and promotion of this implement by the line departments and KVKs can upscale and popularize the implement among the farming community.

Higher wheat productivity in Kandi region through supplemental irrigation with harvested rainwater

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

About 40-50 per cent rainfall goes as runoff during *kharif* season and not stored properly. Hence, the wheat crop grown during *rabi* season is completely rain dependent which results in low productivity due to moisture deficit during low rainfall seasons.

Improved Technology

In *Kandi* region of Punjab out of annual rainfall of 1081 mm, 80 per cent is received during the *kharif* season. The majority of the rains are received in three to four events. This runoff water was harvested in the village pond and used for po st sowing irrigation in wheat crop at crown root initiation stage (CRI) and flowering stage for better productivity and net returns.

Performance

The supplemental irrigation in wheat from harvested rainwater at crown root initiation (CRI) and flowering stage increases the grain yield by 1000 kg/ha and irrigation only at crown root initiation stage increases the wheat yield by 600 kg/ha which varies from 20-40 per cent over rainfed wheat. The supplemental irrigation at CRI and flowering stage results in addi tional benefit of Rs 15,000-22,000/ ha over the rainfed wheat.

Rainfed wheat

Irrigation at CRI stage

Irrigation at CRI & floweing stage

Impact and upscaling

The adoption of this technology will increase the wheat yield in rainfed areas and reduce the risk of crop failure under adverse weather conditions. The technology is widely accepted by the farmers and can be further upscaled through trainings/demonstrations by line departments and KVKs.

Establishment of vegetative barriers (Napier-Bajra hybrid) on field bunds for soil and water conservation under sloppy land conditions

Recommendation Domain

Shahid Bhagat Singh Nagar, Hoshiarpur, Pathankot, Roopnagar and Ajitgarh districts in *Kandi* region of Punjab.

Existing Practice

Soil erosion during the monsoon is major problem in this region. Most of the rainfall goes as runoff which results in low moisture availability to the standing crop during drought period as well as low moisture for the sowing of succeeding *rabi* crops.

Improved Technology

The vegetative barrier of Napier -Bajra hybrid can be raised by cuttings as well as root suckers during the month of February and July. These vegetative barriers hold the soils of the field bunds and break the flow of water which results in percolation of the water in soil. This ultimately improves the soil moisture and reduces the soil erosion and runoff.

Vegetative barrier in farmer field

Vegetative barriers in AICRPDA experimental field

Performance

Establishment of vegetative barriers of Napier- Bajra hybrid on field bunds results in increase in grain yield of *kharif* crops (maize, sesame & blackgram) and enhanced soil moisture for succeeding *rabi* crops besides checking soil erosion . In add ition to this, it also provides fodder for the animals during the lean period as well as potential source of biomass energy.

Impact and Upscaling

Farmers in the domain area are adopting this technology as it control s soil erosion and conserves soil moisture for the succeeding *rabi* crops. Extension efforts through exposure visits to the farmer fields adopting this technology by state agriculture department and KVKs will further increase the adoption of vegetative barrier on field bunds.

Doable Agriculture Technologies under Rainfed Conditions in Kandi Region of Punjab

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Citation:

S.C. Sharma, Vijay Kumar, Vivek Sharma, Anil Khokhar, G. Ravindra Chary & Manmohanjit Singh (2015). Doable Agriculture Technologies under Rainfed Conditions in Kandi Region of Punjab

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Sponsored by:

All India Co -ordinated Research Project for Dryland Agriculture
National Initiative on Climate Resilient Agriculture
Central Research Institute for Dryland Agriculture
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First Edition: December, 2015

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