

## Effect of Improved Technology on Remunerative Crops of Chikna Watershed in Submontaneous Tract of Punjab

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### Abstract

The results of the investigations carried on soils with different fertility status revealed that by utilizing improved technology the yield of various crops can be increased from 11.5 to 62.8% over farmers' practice. This increase in grain yield was attributed to 20—80% adoption of improved rainfed technology. The major earning of farmers of Chikna watershed is based on rainfed agriculture but the erratic behavior of rain leads to poor productivity of different crops in this watershed. Also, the undulating topography, poor fertility status and poor texture are the main constraints of low productivity of different crops along with meager adoption of improved rainfed technology. The identification and selection of remunerative cropping sequences on low, medium and high fertility soils are the only way out to get maximum benefit from these soils. Maize-wheat and gram-wheat cropping sequences can be successfully practiced on all types of soils to get the highest market returns (Rs 54,088 and Rs 58,064 respectively) on heavy textured soils. So, with the adoption of latest techniques of cultivation, the farmers of Chikna watershed can get higher productivity of their crops along with adoption of suitable cropping techniques.

**Key words :** Cropping sequences, Field operation, Improved practice, Field techniques.

Rainfed agriculture has its distinct importance in the sphere of agricultural production. About 70% of the total cultivated area in India is rainfed and contributing about 42% of the total production of food grains to feed the burgeoning population. The rainfed areas suffer due to frequent weather aberrations resulting in frequent crop failure. Since the cultivation in rainfed areas involved high risk of crop failure, farmers in such a situation are unable to make high investment in their land for increasing production. In Punjab, the submontaneous tract adjoining undulating piedmont plains in the south of Shiwalik hills is popularly known as the Kandi zone. This zone covers parts of Roop Nagar, Nawanshahar and Hoshiarpur districts of the state. The total area of this belt is 0.5 million hectares constituting about 10% of the total geographical area of the state. The land is undulating and sloppy and the average annual rainfall is about 1,000 mm, 80% of which is received during July, August and September (1). Although this belt has a distinct advantage of having rainfall higher than other parts of the state, but due to topographical and lithological constraints, most of the rainfall is lost as runoff. Moreover, the irrigation facilities in this zone are limited and most of the area is rainfed.

As a consequence, distinct cropping systems have developed over time (2).

The terrain of Chikna watershed is dissected by numerous annual and seasonal streams called *choes* due to which a major part of the rainfall is not utilized by the crops and thus lost through run off (1, 3). The farmers of this zone are cultivating different crops under different cropping sequences depending upon the fertility status of the existing soils (4, 5). In this watershed maize, mungbean, mash and

**Table 1.** Physico-chemical characteristics of soils in Chikna watershed.

Soil fertility parameters	Values
pH	7.8
EC (dS/m)	0.22
Organic carbon (%)	0.59
Available N (kg/ha)	262
Available P (kg/ha)	13.6
Available K (kg/ha)	88
Texture	
Sand (%)	68.5
Silt (%)	23.5
Clay (%)	8.0
Textural class	Sandy loam

**Table 2.** Distribution of rainfall during the period of study in Chikna watershed.

Month	1998-1999 Standard week of the year	No. of days	Monthly rain (mm)	1999-2000 Standard week of the year	No. of days	Monthly rain (mm)
<i>Kharif Season</i>						
June	23, 24, 25, 26	3	100.94	23, 24, 25, 26	11	147.4
July	27, 28, 29, 30	16	784.80	27, 28, 29, 30	17	463.6
August	31, 32, 33, 34, 35	12	292.60	31, 32, 33, 34, 35	8	182.9
September	36, 37, 38, 39	13	191.4	36, 37, 38, 39	4	65.1
<i>Rabi Season</i>						
October	40, 41, 42, 43, 44	Nil	Nil	40, 41, 42, 43, 44	Nil	Nil
November	45, 46, 47, 48	Nil	Nil	45, 46, 47, 48	Nil	Nil
December	49, 50, 51, 52	Nil	Nil	49, 50, 51, 52	1	1.8
January	1, 2, 3, 4, 5	4	55.2	1, 2, 3, 4, 5	6	84.0
February	6, 7, 8, 9	3	61.8	6, 7, 8, 9	8	37.6
March	10, 11, 12, 13	7	129.4	10, 11, 12, 13	3	25.3
April	14, 15, 16, 17, 18	11	94.3	14, 15, 16, 17, 18	1	1.5
May	19, 20, 21, 22	7	41.8	19,20, 21, 22	2	16.5
Total rain (mm)	1998-1999		1,830.80	1999-2000		1,025.5

sarson are being cultivated during *kharif* season, whereas wheat, taramira, gram and lentil are sown during *rabi* season. These crops in this zone are

being grown using traditional methods and rainfed technology is not being properly utilized due to lack of knowledge and farmers poor economic conditions.

**Table 3.** Benchmark report of Chikna village before the start of operational research project.

<b>Selection of Crop Cultivars on Different Textured Soils</b>		
<i>Rabi</i> season crops	Type of soil	Technology used
Wheat	Low to medium fertility soil	Farmers grow crops with traditional methods of sowing (broadcasting) and used only 125 kg urea/ha to wheat. No P or K fertilizers were applied to any crop. Farmers add only FYM and less chemicals.
Raya	High fertility soils	
Gram	Low fertility soil	
Lentil		
Taramira	Medium fertility soil	
<i>Kharif</i> season crops	Type of soil	Technology used
Maize	Low to medium fertility soil	Traditional methods of sowing (broadcasting) and used only 125 kg urea/ha to maize. No P or K fertilizers were added to any crop. Farmers only FYM to crops and remove weeds mechanically.
Mash	High fertility soils	
Moong	Low fertility soil	
Groundnut	Medium fertility soil	
Bajra	Low fertility soil	
<b>Cropping Sequences Followed on Different Types of Soils</b>		
Low fertility soil	Maize-wheat Groundnut-wheat Moong-Wheat Bajra (F)-Wheat	Maize-wheat rotation yields less on light texture soils but other systems perform better
Medium fertility soil	Maize-wheat Moong-wheat Moong-raya	Maize-wheat rotation yields more on medium soils as compared to light soils
Heavy textured soils	Maize - wheat + raya	Bumper yield of crops

**Table 4.** Effect of transfer of technology on performance of *rabi* and *kharif* crops on different types of soils in Chikna watershed. Rates of commodities (Rs per quintal) : wheat (921), gram (3,871), maize (792), taramira (1,940), lentil (1,104), sesamum (2,540), moong (1,090), mash (1,144).

Different crops	Texture of soil	Grain yield (q/ha)	Grain value (Rs)
Wheat	Low fertility soils	25.10	23117
	Medium fertility soils	29.10	26801
	High fertility soils	32.50	29932
Gram		6.50	29032
Lentil	Low fertility soils	5.40	4857
	Medium fertility soils	3.50	6790
Taramira	Light soils	19.70	15602
	Medium fertility soils	23.40	18532
Maize	High fertility soils	30.50	24156
	Low fertility soils	5.90	6749
Mash			
Mung-bean	Medium fertility soils	8.60	9374
Sesamum	Low fertility soils	4.10	10414

In general, it is important to grow different crops in specific sequence based on soil fertility status using latest rainfed technology. Keeping these points in view, the present investigation was undertaken with the following objectives : To increase the yield of different crops at farmers fields using demonstrations on improved technology in Chikna watershed, and to find out the most profitable and remunerative crops and cropping sequences in the watershed.

### Methods

The experimental study was conducted for two years (1998-99 to 1999-2000) in Chikna watershed under operational research project (ORP) falling under the command of Zonal Research Station (PAU) for Kandi Area, Ballawal-Saunkhri, in Nawashaher district of Punjab. The demonstrations based on improved technology on different crop cultivars were conducted at farmers fields during *rabi* and *kharif* seasons. Different crops were selected for sowing based on the fertility status of the soil after detailed survey of the area falling under Chikna watershed. In this watershed the farmers were cultivating different crops with traditional methods of sowing and they were unaware of latest dry land technology. Taking into account the land capability classification

and levels of organic carbon (OC), available N, P and K the soils of Chikna watershed area were classified into low, medium and high fertility. Further, depending upon the fertility status of soil, field demonstrations on various crops were conducted. The demonstration trials were conducted with the view to transfer of improved rainfed technology at farmers fields. Soil samples and grain yield data of different crops were collected for the period. The grain yield data were collected from the demonstrations conducted under operational research project on low, medium and high fertility status soils. Plant grain data were recorded from the farmers fields to study the impact of improved technology over farmers practice under rainfed conditions. For different physico-chemical characteristics of the experimental area, the analysis was carried out in the laboratory. For pH soil suspension was prepared with distilled water keeping 1 : 2 soil to water ratio and the concentration of hydrogen ions in soil (pH) of suspension was measured by potentiometric method (6). The electrical conductivity of soil suspension is proportional to the concentration of soluble salts (7). The cation exchange of the soil samples was determined by the method described by Jackson (6). Rapid titration method (wet digestion method) was used for organic carbon determination (8). Available nitrogen was determined by the method described by Subbiah and Asija (9). Available phosphorus in soil samples was determined by the method described by Olsen et al. (10). Available potassium content of soil was determined by the method described by Merwin and Peech (11). Soil texture was determined by standard international pipette method. The USDA size fractions for separation of sand (0.02—2.0 mm) by gravity sedimentation method of Day was followed (12). Sand content was separated by using 70-mesh sieve. Similarly, the crops grain yield data under different cropping systems were recorded.

### Results and Discussion

#### *Soils of Chikna Watershed and Rainfall Distribution*

The major soil texture is silty loam having 68.5, 23.5 and 8.0%, silt and clay, respectively (Table 1).

**Table 5.** Effect of improved technology on yield of different crops over farmers practice (impact of technology). LS—Loamy sand ; SL—Sandy loam ; L—Loam ; FP—Farmers practice ; IP—Improved practice ; IT—Improved technology.

Crop cultivars	Type of soil	Technology used	Demonstrations	Yield of Crops (q/ha)		Percent increase over FP
				FP	IP	
Maize	LS	Variety	8	16.30	19.90	22.5
	SL		10	19.30	27.70	43.5
	LS	N sources	6	14.80	18.60	25.6
	SL		6	12.60	20.00	58.7
	L		6	17.90	25.20	40.7
	SL		4	14.80	18.50	25.5
Wheat	LS	Weed control	4	14.50	19.80	25.0
	SL	Variety	10	25.60	32.00	25.0
	SL	N sources	10	23.50	26.20	11.5
	LS	Sowing method	8	26.30	29.60	12.5
	LS	Termite control	8	24.20	30.00	24.0
	LS	Weed control	6	20.20	25.50	26.2
Gram	LS	Varieties	8	8.50	12.40	45.9
	LS	*IT	10	6.70	10.90	62.8
Lentil	LS	Spacing	8	3.80	4.50	18.4
	LS		10	5.00	6.30	26.0
Taramira	SL	IT	2	2.50	3.54	41.6
Mungbean	SL		4	5.50	8.50	54.0
Mash	LS		4	4.00	5.90	22.0
Sesamum	LS		10	3.10	4.20	35.5

The average organic carbon content of the soil is 0.59%. It has pH value of 7.8 and electrical conductivity 0.22 dS/m. The soil is low in available N and medium in available phosphorus and potassium. Higher rainfall (1,830.80 mm) was recorded during both the seasons of the years 1998-99 and thus bumper yield of various crops were reported (Table 2). On the other hand, less rainfall was recorded during the year 1999-00 which adversely affected the yield of various crops compared to the previous year because of the erratic behavior and distribution of rainfall. The over all yields of various crops cultivated in Chikna watershed were adversely affected due to untimely rainfall and its distribution. Under such conditions the farmers of this watershed were able to get good yields of different crops using improved technology.

*Performance of Different Crops on Low, Medium and High Textured Soils of Chikna Watershed*

A benchmark survey of Chikna watershed

showed that farmers of this watershed were using traditional methods of crop cultivation without addition of any P and K fertilizers (Table 3). So, with farmers participatory approach of different crops were selected depending upon the fertility status of soils existing in the watershed. Field experiments and demonstrations were conducted on different crops to study their relative performance. The crops were raised with taking into consideration the rainfed technology related to recommended dose of fertilizers, dates and methods of sowing, seed treatment, weed control, use of insecticides and pesticides. Among various crops tested during these years wheat crop gave the highest grain yield of 32.50 q/ha on heavy textured soil and the lowest grain yield was obtained for sesamum (4.10 q/ha) on light textured soils (Table 4). The grain yields of various crops were multiplied with their corresponding market prices implied that among cereals wheat crop was found to be more remunerative followed by maize and gram crops (Table 4). The different yields of maize (25.10—32.50 q/ha) and wheat (19.70—30.50 q/ha) were obtained low, medium and high fertility soils. The data

also showed that light textured soils (marginal) were suitable for successful growing of gram and lentil during *rabi* season, and mash and sesamum during *kharif* season (13). These soils are loamy sand and existed on deposits adjoining the seasonal streams (choes beds). These soils are generally coarse textured (sand to loamy sand) with uneven topography having low organic carbon and available N, P and K (Table 2). The moisture retentive capacity of these soils is low as these soils have 5—10% clay content (1, 14). Maximum benefits could be taken from these soils by growing crops in mentioned suggested sequences (Table 4). On the other hand, medium fertility soils performed better with respect to yield of different crops than the poor fertility of soils during *rabi* and *kharif* seasons. The main reason for better grain yield of these soils was that these soils occur on slightly piedmont plains and cover large area of Chikna watershed. The fertility and water holding capacity of these soils were better than the light textured soils as these soils have 10—15% clay content. These soils are generally medium in organic carbon, available N and P and the low in available K. Wheat, maize, taramira and mungbean crops could be grown to get maximum yield (1, 2) on these soils. Among various crops tested during *rabi* season wheat crop gave the highest grain (32.50 q/ha) yield, whereas sesamum gave the lowest grain yield (4.10 q/ha). The figures of the gross value showed that wheat crop on heavy textured soil was more remunerative followed by gram, maize and sesamum during *rabi* and *kharif* seasons. The market prices of various commodities also showed that wheat (Rs 29,932), gram (Rs 29,032), maize (Rs 24,156) and sesamum (Rs 10,414) brought premier in the market, whereas maximum market returns (Rs 54,088) were obtained from maize-wheat rotation practiced on heavy textured soils (Table 4). Little higher market return was obtained from gram-maize rotation.

The soils existing in some parts of Chikna watershed were heavy textured and had high fertility and more water holding capacity. These soils occur on nearly level to gently slopping piedmont plains with loamy to clayey texture with more than 18% content of the clay (2). Also these soils have higher water holding capacity and have more production potential under maize-wheat system. Both wheat and maize performed better on these soils (Table 4) as compared

to yields of same crops on medium and light textured soils. However, under the situation of heavy rainfall the yield of maize crop gets adversely affected due to prolonged wet conditions. The maize-wheat cropping sequence was successfully practiced on heavy textured soils. The sequence was more remunerative on heavy textured soils and therefore more economical to the farmers of Chikna watershed. These results were supported by Verma et al. (3) and Sharma et al. (4) on maize-wheat crop rotation.

#### *Impact of Improved Technology and Increase of Crop Yields over Farmers Practice*

The results of the demonstrations conducted at cultivators fields ensured higher yield of different crops varying from 11.5—62.8% increase over farmers practice (Table 5). The maize on medium textured soils recorded 58.7% increase in grain yield over farmers practice. The maximum and minimum increase in grain yield recorded over farmers practice was obtained in gram (62.8%) and wheat (11.5%) on light textured soils. The maize on light textured soils (43.5%), gram (45.9%) and taramira (41.6%) reported almost same increase in per cent yield over farmers practice. However, 54% increase in grain yield was reported by mungbean on medium textured soils over farmers practice. The maximum production of these crops could be taken if the crops are grown in cropping sequences recommended for various types of soils and sowing methods, sowing time, fertilizer application, insect-pest and weed control were done following recommendations of the crops (5, 15).

#### *Conclusion*

Thus it can be concluded that different crops and cropping sequences were successfully practiced on low, medium and high textured soils. Maize-wheat sequence can successfully be adopted on all types of soils, however, there was yield decline under medium and light textured soils and maximum yield can be obtained under heavy textured soils. The other crops can be successfully grown on these soils but maize, wheat and gram crops were more remunerative for Chikna watershed. On heavy textured

soils maize-wheat cropping sequences is being successfully practiced. Farmers are adopting various techniques to increase the productivity of different crops on sloppy lands but still there is a big gap in reaching the latest technology to farmers fields.

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