REVIVAL OF GREEN REVOLUTION THROUGH MECHANIZATION OF DRYLAND AGRICULTURE

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FOREWORD

Dryland Agriculture inherently suffers from erratic monsoon behavior and is a risk prone enterprise. Fluctuating sowing season is very common in dryland areas due to erratic monsoon. Contingency plans often suffers due to non-availability of sufficient farm power and precision tools to complete sowing operations within short period of time. Therefore, mechanization is one of the key factors in success of dryland farming in India. CRIDA and other organizations have developed many efficient tools and implements suitable for drylands.

Conservation of soil and water, efficient utilization of farm power, improving nutrient use efficiency, crop establishments etc are some of the major issues leading to demand for precision operations. Research programme on dryland mechanization led by CRIDA under NATP Project demonstrated the potential of enhancing crop productivity by 20-50% and reduction of operation costs by 20-60% indicate a potential in mechanization of dryland.

National food security now depends on production from drylands in future. Selective mechanization matching to available power size and farm holdings is pre-requisite to ensure enhancing the productivity of dryland agriculture.

I congratulate the authors for their efforts in bringing out this publication. I am sure this will be very useful to scientists, planners, administrators, development agencies and public at large for understanding role of mechanization in improving productivity and sustainability of dryland agriculture leading to second green revolution in India.

August 30, 2004

Y.S. Ramakrishna
Director,
CRIDA, Hyderabad

PREFACE

Dryland Agriculture in India is a major component of agriculture with 68% of cultivated area falling under this category. Most of the cereals, oilseeds, pulses, cotton and other crops are grown under drylands with average productivity less than 1t/ha. Shortfall in production of oilseeds and pulses is very predominantly felt. Since the productivity of irrigated food crops like rice and wheat is stagnated and no significant jump in productivity of these crops is eminent, the hope of keeping food basket full rests on drylands. Considering population growth rate, we need to double our food grain production by 2015 to ensure food security of the nation.

The potential productivity of dryland crops in the range of 2-5 t/ha has been demonstrated at research farms with precision management of resources. This needs to be expanded to farmers scale. Diminishing human and animal power sources and significant growth of tractor and other mechanized power sources has been changing the power scenario in dryland agriculture. Increasing density of power to certain limit will improve the timeliness of operation, which is critical in drylands. Mechanical power input also changes the need for new tools matching to power size. Precision tools and machinery play very important role in drylands to improve input use efficiency.

Mechanization packages developed under NATP-Mission Mode Project (MM-III-60) on "Use of Improved Tools for Mechanization of Dryland Agriculture" has demonstrated the potential of enhancing productivity of drylands crops in the range of 18-53%, while reducing operation cost by 20-59% and saving of seed/fertilizer to the extent of 31-38%.

Mechanization of drylands has potential of increasing profitability and hence improve sustainability. Since, input of mechanization is very critical for precise and timely completion of operations on large area during limited time period, focused efforts are needed to selectively mechanize dryland agriculture. Availability of implements through custom hiring centres, supply of quality implements by industry need a special policy support.

Mechanical tools and equipments are pre-requisite for operation scale adoption of dryland technologies like soil-water conservation, rain water management, cropping systems, improving soil health, processing & value addition etc . Hence we strongly believe that second green revolution in India has to come from dryland agriculture through mechanization.

Authors have contributed the chapters on various new tools and implements. This knowledge would eminently contribute to revival of second revolution in dryland farming through selective mechanization approach.

August 30, 2004

V.M.Mayande
M.A. Shankar
S.R. Singh
N. Indra Kumar

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The publication entitled "Revival of Green Revolution through Mechanization of Dryland Agriculture" is a result of collective effort of large number of authors who contributed their experiences in their chapters. We wish to place on record the contribution of all authors from various parts of country for their unstinted support in publication of this book.

We are highly thankful to Dr. Mangala Rai, Secretary DARE and Director General, ICAR, New Delhi for encouragement to dryland mechanization project. We acknowledge the support of National Agricultural Technologies Project in publication of this book. We firmly believe that this publication will be highly useful to planners, policy makers, scientists, extension agencies, NGO's and students who are concerned about mechanization input to dryland agriculture.

We are grateful to Dr. J.S. Samra, DDG (NRM), ICAR, Dr. Y.S. Ramakrishna, Director CRIDA, Dr. K.P.R.Vittal, Project Coordinator (AICRPDA), Dr.A.K. Krishnappa, Hon. Vice-Chancellor, Director of Research and Head, Agricultural Engineering Department, UAS, Bangalore for their encouragement and active support for dryland mechanization programme and particularly in bringing out this publication.

We are thankful to all scientific, technical, administrative and support staff of Dryland Agriculture Research Centre, UAS, GKVK, Bangalore and also colleagues Drs. G.R. Korwar, G. Subba Reddy, C.R. Thyagaraj, I. Srinivas, Ravikanth Adake, V. Sreeramulu and S. Veeradas for their active involvement in dryland mechanization programme, encouragement and support in bringing out this publication.

We place on record untiring, devoted and commendable work of Mrs. Kakuli Chakraborty in organizing and typesetting the manuscript. We will be most happy to receive any suggestions and comments on the publication and hope the efforts will be rewarding by extending the benefit to large number of target readers.

August 30, 2004

V.M.Mayande
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About Editors

Dr. V.M. Mayande, Principal Scientist (Farm Machinery & Power) working at Central Research Institute for Dryland Agriculture, Hyderabad. As Principal Investigator of NATP Mission Mode Project on dryland Mechanization, he coordinated the work of ten centres. He holds a Ph.D degree from Indian Institute of Technology, Khargpur and M.Tech from G.B. Pant University of Agriculture and Technology, Pantnagar. He is recipient of several professional awards and honours including most prestigious **Rafi Ahmed Kidwai Award** of ICAR for outstanding contribution in Engineering and Technology. He also holds two design patents. He has been instrumental in popularizing mechanization in dryland areas and commercialized 12 designs to private industries for production and sale. He has about 150 research publication to his credit. He is also handling several important assignments as Member Secretary, Research Advisory Committee, Member Secretary, Quinquennial Review Team and Member, Institute Management Committee. He is a fellow, Indian Society of Agricultural Engineers, New Delhi.

Dr. M.A. Shankar, Chief Scientist, Dryland Agriculture Research Centre, working at G.K.V.K Campus, University of Agricultural Sciences, Bangalore. He holds a Ph.D degree in Agronomy and had been instrumental in organizing a National Seminar on "Revival of Green Revolution through Mechanization of Dryland Agriculture" at Bangalore. He is leading a multidisciplinary group of researchers and has made immense contribution to dryland agriculture. His emphasis on mechanization in dryland agriculture and adoption of implements at research farm has attracted attention of dryland researchers and thus pioneered dryland mechanization in Karnataka.

Dr. S.R. Singh, Chief Scientist, Dryland Agriculture Research Centre, working at Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. He holds a Ph.D degree in Agricultural Engineering. He is also Head, Department of Farm Engineering at BHU, Varanasi. He has designed several implements for dryland farming specially rainfed rice based system. He is leading a multidisciplinary team of researchers and immensely contributed in improving productivity of dryland agriculture in Varanasi region. He is also holding several important national assignments including a member of Governing Board, Indian Council of Agricultural Research, New Delhi.

Er. N. Indra Kumar, Associate Professor (Agril. Engg) working at Dryland Agriculture Research Centre, GKVK, UAS, Bangalore. He holds a Masters degree in Agricultural Engineering from USA and had been instrumented in popularization of mechanization in dryland areas of Karnataka.

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CONTENTS

CHAPTER 1

Minimum Tillage and Residue Incorporation

S.K. Rautaray[1]

Abstract

Straw management : incorporation or retrieval after grain combining in rice-wheat fields has become an immediate concerns of farmers to avoid in-field burning. The results of cultivation systems for straw incorporation in rice-wheat fields showed that direct rotavation under chopped straw condition (minimum tillage) was more appropriate being a shallower working system with higher work rate and substantially less energy demanding than the mould board plough based cultivation system. There found no significant difference of the values of benefit-cost ratio for cultivation of rice and wheat in straw/non straw fields indicating thereby no immediate advantage of straw incorporated cultivation although being of organic base it may prove beneficial in long run.

The chapter describes the cultivation systems including the minimum tillage approach for straw incorporation in vertisols and the related performance of subsequent crops (rice and wheat) in straw fields compared to non-straw fields with a view to find out what equipment and practices are energy efficient and cost-effective for straw tillage in combine harvested rice-wheat fields for subsequent sowings.

Introduction

The combine harvested rice-wheat fields are generally left with long loose straw/stubbles in the field. Nearly 75% of rice-wheat straw goes as waste (loss of nutrients) affecting soil health besides causing environmental pollution due to burning by farmers prior to tillage for subsequent sowings. The primary reason for burning of straw in the field although an easy practice for the farmers is mainly due to lack of suitable straw management practices for incorporation or retrieval of straws from combine harvested rice-wheat fields which otherwise create problems for subsequent sowings.

Several researchers (2-5) have indicated that the rice-wheat straws being burnt are rich renewable soil enriching resource and nutrient building materials when incorporated properly into soil. For incorporation some farmers use plough and disc harrow. Although both the implements incorporate stripped/chopped straw but it requires large number of operations giving higher operational cost and greater soil compaction. Further with ploughing alone the stripped straw is placed at comparatively deeper layer (150-200 mm) where it takes longer time to break down particularly in heavy soils. With discing the chopped straw is partially mixed with soil limited to top about 2 mm depth. Therefore it was considered to be appropriate to develop suitable equipment and practices for effective incorporation of straw in combine harvested rice-wheat fields as alternate to burning. It is desirable that shallower cultivation (75-100 mm) associated with fewer operations (one or two) should well mix and incorporate chopped straw in the top to around 100 mm depth achieving a bury between 80-90% so as to give adequate soil contact for the straw to breakdown rapidly. Experiments were conducted with objective (a) to develop energy efficient and cost-effective

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straw tillage in combine harvested rice wheat fields for subsequent sowings; and (b) to evaluate the performance of crops in straw tillage compared to non-straw fields.

Materials and methods

Rotavator for minimum tillage and mould board ploughing were compared for incorporation of rice-wheat straw in vertisols in terms of energy requirements and cost of incorporation. The performance of rice and wheat sown subsequently in straw fields were compared to non-straw fields in respect of initial establishment, growth and yield. Prior to incorporation the conditions of straw and stubbles from the previous harvests were measured.

Straw condition

After grain combining the general condition of straw and stubble left in the field is given in Table 1.

Table 1 : Condition of straw in the field after grain combining (1)

Sl. No.	Straw Parameters	Rice (IR-36)	Wheat (HI-8498)
1	Size of straw, (Length x Diameter),mm	540 x 2.9	650 x 3.1
2	Size of standing stubble (Length x Diameter), mm	335 x 2.7	340 x 3.4
3	Weight of loose straw per sq.m, g	365 (13.2% wb moisture content)	325 (8.2% wb moisture content)
4	Weight of standing stubbles per sq.m,g	180 (13.8% wb. moisture content)	160 (8.3% wb moisture content)

Straw treatment and assessment

The straw-stubbles were broken down/chopped by one operation of tractor operated stubble shaver/shredder and the size/weight of straw prior to incorporation were measured (Table 2);

Table 2 : Analysis of length and weight of straw prior to incorporation.

Sl. No.	Straw condition		Weight of straw, % of total			
			Length <50 mm	Length 50-100 mm	Length 101-150 mm	Length >150 mm
1	Combine harvested	Rice	4	18	23	55
		Wheat	6	12	24	58
2	Shredded	Rice	22	16	26	36
		Wheat	44	32	10	14

The average size of straw prior to incorporation were 148 and 122 mm for rice and wheat respectively. The weight fractions of chopped straw<100 mm length was 76% for wheat compared to 38% for rice.

Results and discussion

Performance of tillage implements for straw incorporation

Field operations were carried out as per the treatments: T1 (One MB ploughing + one rotavating) and T2 (One rotavating) to incorporate the chopped straw and stubbles; estimated at 4.82 and 5.81 t/ha for rice and wheat respectively. The control treatment (T3) included 3 sweep operations for tillage after sickle harvest of rice and wheat for comparison. The results are presented in Table 3.

Table 3: Energy requirement and cost of incorporation of rice-wheat straws during tillage operations

Type of straw field	Treatment	Implement used	Time required, h/ha	Direct energy used, MJ/ha	Cost of operation, Rs/ha	Amount of straw incorporated, %	Total operational energy, MJ/ha	Total cost of operation Rs/ha
Combine harvested wheat straw field	T1	Stubble shaver (1) MB plough (1) Rotavator (1)	2.63 5.26 2.94	479 1195 635	486 1073 652	- 75 14	2308	2213
Combine harvested wheat straw field	T2	Stubble shaver (1) Rotavator (1)	2.63 3.45	479 706	486 744	- 58	1185	1231
Non-straw wheat field	T3	Duck foot sweeps (3)	7.40	1389	1332	-	1389	1332
Combine harvested rice straw field	T1	Stubble shaver (1) MB plough (1) Rotavator (1)	2.86 5.00 3.03	537 1108 654	537 1010 672	- 78 12	2299	2219
Combine harvested rice straw field	T2	Stubble shaver (1) Rotavator (1)	2.86 3.70	537 736	537 792	- 62	1273	1329
Non-straw rice field	T3	Duck foot sweeps (3)	8.01	1504	1441	-	1504	1441

( ) Figures show number of passes.

Fig.1: Mold Board Plogh in operation

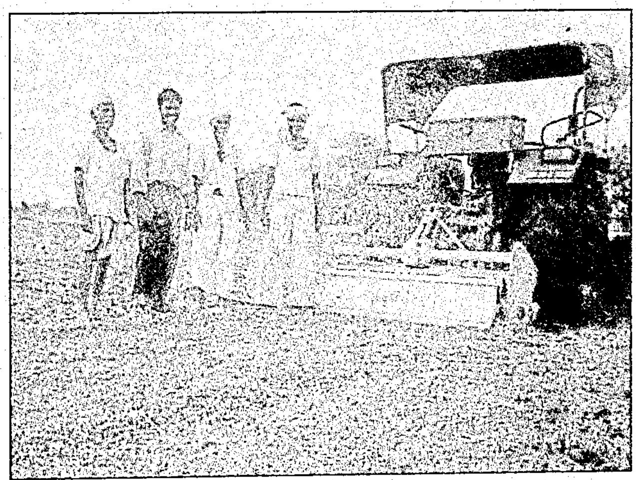

Fig.2: Krushivator in operation

It was found that with M.B. plough (Fig.1) + rotavator (Fig.2) combination, the degree of incorporation of chopped rice-wheat straw was 89.7% at 50-125 mm depth compared to average of 60.4% on surface profile upto 50-70 mm depths with direct rotavation.

The mould board ploughing although is a relatively slow operation and has a high energy demand it gave almost straw free surface by burying average of 76.7% of straw on the surface. The direct operation of rotavator was found to be 46.7% energy efficient and 42.2% cost-effective but with lesser degree of incorporation of chopped straw (32.7%) compared to mould board ploughing + rotavating combination.

The action of the rotavator was to impart rotation to successive bites of soil so that the chopped straw falls between those bites for mixing with the soil.

Performance of seed cum fertilizer drill for subsequent sowing in straw fields

Sowing of wheat in rice straw and dry-seeded rice in wheat straw fields were carried out (seed rate = 100 kg/ha for rice and wheat both) at shallow depths of 50-60 mm with row spacings of 200 mm (Table 4).

In direct rotavation the field capacity and field efficiency of drill were lower by 24% and 38.8% compared to mouldboard ploughed and non-straw fields respectively due to repeated chocking of drill tines. At friable condition of the soil (moisture content 21.5-22.5% wb) the drillings could be done satisfactorily in straw fields.

Table 4 : Performance of seed cum fertilizer drill

Performance parameters	Wheat straw/non-straw (control) - rice sown			Rice straw/non-straw (control) - wheat sown		
	T1	T2	T3	T1	T2	T3
Effective field capacity, ha/h	0.28	0.21	0.34	0.26	0.20	0.33
Field efficiency, %	72	64	78	70	61	78
Direct energy used, MJ/ha	670	893	552	722	938	568
Cost of sowing operation, Rs/ha	653	871	538	704	915	554

Considering the joint package of tillage and seeding in straw fields it was found that direct rotavator + drill compared to mould board plough + rotavator and drill combination was energy efficient for 26.8% for wheat in rice straw and 32.2% for rice in wheat straw fields with cost effectiveness for 23.2% for wheat in rice straw and 26.7% for rice in wheat straw fields.

Performance of crops in straw fields

The mean emergence counts with subsequent establishment and growth of crops in straw and non-straw fields were found similar (Table 5). In straw incorporated fields due to yellowing appearance of seedlings at the initial stage (25 days after sowing of wheat and 20 days after sowing of rice) 25% additional N was top dressed following one light irrigation. Subsequent establishment and growth of crops in straw and non-straw fields were found similar. Dry sown rice at 30 DAS in wheat straw incorporated field by rotavator and wheat (HI-8498) at harvest in rice straw incorporated field. The incorporated rice straw was decomposed after 50- 60 days in wheat fields whereas the wheat straw got decomposed after 40- 50 days in rice fields. The straws on the surface remained for a longer period without affecting the crops. Mechanical weedings by use of improved weeders (twin wheel hoe) at the early stage of rice in straw fields was done at low field efficiency due to repeated chockings.

The performance of crops in general was found largely unaffected by the choice of straw incorporation. The poor performance of rice was due to unfavorable weather with low rainfall and frequent dry spells. The production economics and energy used for cultivation of rice-wheat in straw fields is given in Tables 6.

Table 5: Plant population and yield

Performance parameters	Wheat straw/non-straw (control) - rice sown			Rice straw/non-straw (control) - wheat sown		
	T1	T2	T3	T1	T2	T3
Effective field	0.28	0.21	0.34	0.26	0.20	0.33
Mean emergence count, No/sq.m	344	336	358	174	172	178
Plant population at harvest, No/sq.m	386	384	376	284	278	272
Mean grain yield, g / sq.m	282	250	247	435	427	422

Table 6: Production economics and direct energy used for rice-wheat cultivation in straw fields

Particulars	Wheat straw/non-straw (control) - rice sown			Rice straw/non-straw (control) - wheat sown			Rice-Wheat straw/ non-straw (control) -fields		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Grain yield, t/ha	2.54	2.28	2.01	4.28	4.12	4.08	6.82	6.40	6.09
Cost of production, Rs/ha	10569	9805	8799	12020	11340	10524	22589	21145	19323
Benefit-cost ratio	1.15	1.12	1.10	2.31	2.36	2.52	1.73	1.74	1.81
Direct energy based, MJ/ha	7123	6222	5371	8827	8017	7053	15959	14239	12424

*7*Sale price of wheat(HI-8498), Rs/kg = 6.50*
Sale price of rice (IR-36), Rs/kg = 4.80

The results showed that the total yield productivity of rice-wheat system was increased by 4.8-10.7% in straw fields compared to non straw cultivations. In mould board plough +rotavator treatment besides straw incorporation it has likely added the advantage of deep ploughing for higher yield although the cost of production was higher by 5.02% and 15.17% from direct rotavator and non straw (control)cultivation respectively. The values of benefit cost ratio were at par between straw and non straw cultivations.

Conclusion

1) The chopped rice-wheat straw (89%) could be incorporated satisfactorily at 50-125 mm depths by mould board plough + rotavator combination and 60% on surface profile up to 50-60 cm depths by direct rotavator operation.

2) The joint package of direct rotavator followed by drill compared to mould board plough + rotavator + drill combination for straw incorporation and subsequent sowings was found to be energy efficient and cost effective.

3) The mould board plough + rotavator combination gave almost straw free surface for unimpaired drillings. The mould board ploughing besides straw incorporation added the advantage of deep ploughing and supported the crop for higher performance and yield (10.7%) compared to non straw cultivations.

4) There found no significant difference of the values of benefit-cost ratio for cultivation of rice and wheat in straw/non-straw fields indicating thereby no immediate advantage of straw incorporated cultivation although being of organic base it may prove beneficial in long run.

5) The effectiveness of straw incorporation may not necessarily be a guide to overall benefit cost but direct rotavating under chopped straw condition was more appropriate being a shallower working system with higher work rate and substantially less energy demanding than the mould board plough based cultivation system.

Recommendations and suggestions

(i) Since mould board ploughing is time, energy and cost demanding it is desirable that shallower (depth=75-100 mm) cultivations with fewer operation (1 or 2 passes) by rotavator should be preferred to mix the chopped straw to give adequate soil contact for the straw to decompose rapidly. Combine tillage equipment in the form an integrator to chop, invert and mix the straw in the top to around 100 mm depth achieving a burry of 80-90% and simultaneous drilling of crop in single operation may be more appropriate.

(ii) The chopping by stubble shaver/shredder gave comparatively longer straw and it created problems with repeated chocking of drill tines and operation of weeders. A fine chopped straw (maximum size 20-30 mm) at the time of combining would be useful. The fine chopped straw on the surface may also prove beneficial for direct drillings compared to burying by mould board ploughing.

(iii) In wheat straw incorporated field direct-dry seeded rice was only possible as the burried straw floated on the surface during puddling and created problem for transplanting of rice seedlings. Therefore the technology of direct-dry seeded or alternative crops rice in straw fields may be perfected for higher returns.

References

1. Anonymous, 2002. Annual progress report of NATP:MM sub project on Mechanization of rice wheat cropping system for increasing the productivity, CIAE, Bhopal - 462 038.
2. Beri, V., and Sidhu, B.S. 2002. Effect of straw incorporation on nutrient content of soil and strategies for fertilizer management, Deptt. of soils, PAU, Ludhiana.
3. Misra, A.K., Pennuli, D.K., and Tripathi, A.K. 2002. Effect of straw mulch on physical characteristics of soil-water conservation in rice-wheat cropping system, Paper presented in the group meeting on straw management in combine harvested rice-wheat fields, CAE, PAU, Ludhiana, 2002.
4. Sidhu, B.S., and Beri, V. 1989. Effect of crop residue management on the yields of different crops and soil properties, Biological wastes, CAE, PAU, Ludhiana.
5. Jalota, S.K. 1997. Soil water evaporation : Tillage and crop residue effects, Deptt. of soils, PAU, Ludhiana. sowings was found to be energy efficient and cost effective.

CHAPTER 2

Comparative Study of Tillage Implements in Vertisol

Atul K. Shrivastava, V.C. Singh, R.A. Ram and S.K. Jain[1]

Abstract

Trials were conducted to evaluate the performance of a tractor drawn (T.D.) rotavator, T.D. nine tyne cultivator and T.D. disc harrow for seed bed preparation under dry field conditions as well as T.D. rotary puddler for puddling operation in wet field conditions. The performance of T.D. rotavator was found to be better than other implements for both the soil conditions.

The fuel saving by rotavator was found to be 56 per cent and 51 per cent as compared to cultivator and disc harrow respectively for preparing fine seed bed. Also, the time was saved by rotavator to the tune of 23 and 19 per cent as compared to cultivator and disc harrow respectively. During puddling operation by rotavator the fuel and time savings both were 21 percent in comparison to T.D. puddler. It was found that only one operation of rotavator was sufficient to prepare fine seedbed and for better puddling operation.

Introduction

The growth and development of crops mainly depends on improving the land by loosening upper layer of soil, mixing of soil with fertilizer and by removing the weeds. These operations are carried out by various tractor drawn (T.D.) implements like mould board plough, cultivator and disc harrow in dry fields and puddler in wet field conditions. The land preparation aspect in vertisol is an energy intensive operation due to presence of heavy soil and tendency to develop cracks. There is also lack of time for land preparation between harvesting of paddy and sowing of the *rabi* crop. As such, field contains crop residues and weeds.

Development of deep cracks creates difficulty with conventional implements. Clod formation in vertisol requires operations on conventional implements to be carried out for preparing fine seedbed. Anonymous (2002) stated that for land preparation T.D. rotavator in heavy soil gave 53% saving of time and 28% of operational cost when compared with indigenous T.D. blade harrow. With the above limitations in view, a comparative study was undertaken to evaluate the T.D. rotavator with T.D. cultivator and disc harrow in dry soil conditions and with T.D. puddler in wet soil conditions for requirement of energy, operational cost and field efficiency.

Material and Methods

The experiment was conducted in three consecutive years from 1999 to 2003 at university research farms and nearby villages viz. Sihoda, Bikhwara, Singld, Kusnare and sahapura in vertisol. The rotavator of model HR 112/125 was used for evaluation. The overall dimensions of the machine were 1650 x 650 x 1000mm with L type blades that were 42 in number.

It required a tractor of 35 hp as its working width was 1.0 m. The rotor speed was 210 rpm. The other implements used for comparison were T.D. cultivator and disc harrow in dry soil for seedbed preparation and T.D. puddler in wet soil for puddling.

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Table 1: Result of soil parameters

Sl. No.	Soil Properties	Before operation		After operation	
		Dry	Puddling	Dry	Puddling
1.	Av. Soil bulk density, gm/cc	1.43	1.13	0.78	0.62
2.	Av. Cone index, Kp at 10cm depth	180	137	89	73
3.	Av. Moisture content (db)	10.2	-	10.2	-

The soil parameters viz. soil bulk density, cone index and soil moisture content were determined as per standard methods for dry soil in rabi and for puddling operation in kharif season are given in Table 1. One hectare area of land was undertaken for testing each implement. In all 10 ha area was utilized for the study. All the implements were operated once in the field and quality of pulverization was observed. In case of inferior quality of pulverization second pass was carried out with that particular implement. The actual width covered, operational speed, depth of operation and weed population before and after 20 days of operation were determined during the test. The field efficiency, energy requirement, fuel and time consumption, clod size and field capacity of the implement were the parameters that were studied.

Results and discussion

The results of the performance of rotavator, cultivator and disc harrow regarding the seedbed preparation are given in Table 2. It reveals that cultivator and disc harrow gave the field capacity of 0.45 ha/h and 0.57 ha/h respectively. To prepare the seedbed at least two operations were needed by cultivator or disc harrow at workable soil conditions. The field capacity of rotavator was recorded 0.34 ha/h but a single operation was sufficient for seedbed preparation with effective weed control. It was observed that the rotavator saved up to 56 per cent energy in terms of fuel than cultivator and 23 per cent than disc harrow because these implements required two operations than rotavator. It was observed that cultivator and disc harrow due to their working operation did not destroy about 20 per cent weeds. Overall, rotavator completely destroyed the weeds and crop residues of paddy and wheat. These weeds were counted after 20 days of operation. The rotavator also saved up to 51 per cent time than cultivator and 19 per cent than disc harrow. It was observed that cultivator and disc harrow needed 5 -6 days interval between first and second operation to get

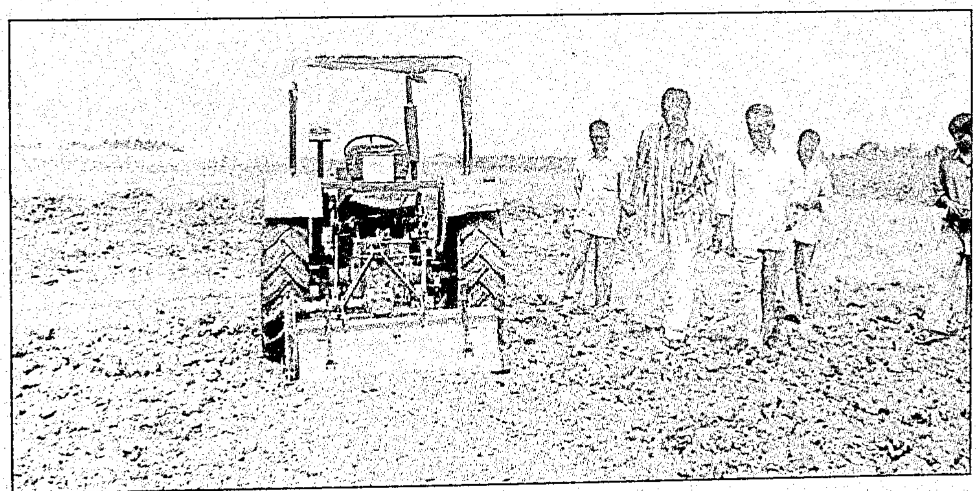

Fig.1: Smooth seedbed with rotavator

smaller clod size due to drying of clods. Similarly 2-3 days are also needed for second operation. These 7 to 9 days period delayed the following crop where as rotavator needs 2-3 days for distortion of weeds due to good pulverization of soil. The rotavator prepared fine seedbed than cultivator and disc harrow for clay and clay loam soils (Fig.1). It also provides uniform plant population in succeeding crop.

If the puddling operation was not performed in time then weeds obstruct the puddler due to its height and density of weeds. The rotavator was used for puddling at an operational speed of 4.50 kmph. The performance of the test is given in Table 3. It shows that actual field capacity was 0.38 and 0.68 ha/h of rotavator and puddler respectively. The field efficiency was found to be 70 per cent in both the machines. The rotavator saved 21% fuel and 19% time as compared to puddler.

Table 2: Performance of rotavator in comparison with cultivator and disc harrow for seedbed preparation

Sl.No.	Particulars	Rotavator	Cultivator	Disc harrow
1.	Width of implements, cm	120	200	150
2.	Operation speed, kmph	3.6	3.1	5.5
3.	Depth of operation, cm	14	20	17
4.	Actual field capacity, ha/h	0.34	0.45	0.57
5.	Field efficiency, %	78	72	70
6.	Time required to prepare seedbed, h/ha	2.94	4.44	3.50
7.	Fuel required, l/h	9.40	14.65	11.55
8.	Maximum clod size after operation, mm	43	105	75

Table 3: Performance of rotavator for puddling

Sl. No.	Particulars	Test Results for Puddling	
		Rotavator	Puddler
1.	Width of implement, cm	120.00	200.00
2.	Operation speed, km/h	4.50	4.50
3.	Field capacity, ha/h	0.54	0.90
4.	Field efficiency, %	70	70
5.	Actual Field capacity, ha/h	0.38	0.63
6.	Time required to puddle the field, h/ha	2.63	3.18
7.	Fuel required for puddling l/ha	9.20	11.13
8.	Area of operation, ha	11.00	5.00

Conclusion

It was concluded that only one operation of rotavator was sufficient to prepare fine seedbed and puddling. The tractor drawn rotavator prepares seedbed with saving of 56 % fuel than cultivator and 23% than disc harrow. The rotavator saved 51% and 19 % time than cultivator and disc harrow respectively. Puddling operation by rotavator saved 21% fuel and time. It was concluded that uniformity of plant population was better than local practices due to even distribution of clod size. Also addition of crop residues will be helpful to improve the physical soil structure. The rotavator provides longer life to tractor tire than cultivator.

References

Anonymous, 2002. Annual Report Farm Implements and Machinery presented in xxiv workshop at Tamilnadu Agriculture University, Coimbatore.

Anonymous, 2002. A success story on rotavator published by Central Institute of Agricultural Engineering, Bhopal.

CHAPTER 3

Effect of Tillage on Soil Physical Properties and the Performance of Wheat Crop Grown on Swell Shrink Soils of Central India

Atul K. Shrivastava, S.P. Shrivastava and S.K. Sharma[1]

Abstract

A field experiment was conducted to evaluate the effect of tillage on soil physical properties viz., soil bulk density, penetration force, growth, yield and energy requirement of wheat crop in a paddy-wheat rotation. Puddling either by tractor or desi plough increased bulk density and penetration force and reduced the wheat yield and growth parameters significantly as compared to direct transplanting or drilling. Effect of rabi-tillage although positive but was not significant. Energy requirement and cost of cultivation of *kharif* and *rabi* crops with different treatments were calculated. Crop yield and benefit cost ratio of puddling by tractor for paddy and M.B. ploughing plus cultivator for wheat is recommended for the vertisols of central India.

Introduction

The green revolution has not fulfilled expectations in the black soil region due to difficulty in managing these soils. Vertisols covering an area of 73 million hectare in India i.e. 22.2% of the total geographical area of the country are the important groups of soils that are extensively used for crop production in Madhya Pradesh (16.7 m ha). They offer the highest potential for food grain production but for many reasons remain mostly under utilized and unexploited. They become very hard on drying and sticky on wetting making the tillage operations feasible only in a narrow range of soil moisture. Thus these soil largely kept follow during rainy season (18 m. ha. in India and 12 m. ha. in M.P.) and cropped in post rainy season. Due to moisture, nutrient, soil physical environmental stress and aberrant weather the yields are low and un-stable. The future of agriculture in this region, depends on the proper management of these soils.

Paddy wheat rotation is common in the vertisols of Kamore platue of Madhya Pradesh. Total area under paddy and wheat being 127.9 and 146.2 thousand hectares respectively. For obtaining higher yields of paddy, transplanting after puddling is a common practice. However, puddling results in deterioration of soil physical properties thereby resulting in low wheat yields. The vertisols of Jabalpur region usually contains silt (24.2%) and clay (56.47%) which leads to clod formation after ploughing. All efforts to obtain a good tilth leads to soil moisture depletion and wait for few days for sowing of wheat. Sowing of wheat beyond November leads to severe reduction in grain yield.

Therefore, considering above facts study was conducted to assess potential of different tillage systems of wheat establishment after paddy crop grown under un-puddled soil conditions.

Material and Methods

An experiment was conducted at the experimental station, Jawaharlal Nehru Krishi Vishwa

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Vidyalaya, Jabalpur on the vertisols. Physico-chemical properties of the experimental area are given in Table 1.

Table 1: Physico-chemical properties of the experimental soil.

Sl.No.	Properties	Values
1.	Mechanical analysis	
	a. Clay %	56.4%
	b. Silt %	24.2%
	c. Sand %	19.0%
2.	pH	7.6
3.	Electrical conductivity (mm/cm.)	0.8
4.	Calcium Carbonate (%)	3.52
5.	Organic carbon (%)	0.56
6.	Available Nitrogen (kg/ha)	188
7.	Available phosphorus (P_2O_5) (kg/ha)	4.0
8.	Available potassium (K_2O) (kg/ha)	245.5

Tillage operations given during kharif season for paddy establishment were :

(I) Direct drilled paddy (without puddling) KT_1

(II) Direct transplanted paddy (without puddling) KT_2

(III) Transplanted paddy after puddling by bullock drawn puddler KT_3

(IV) Transplanted paddy after puddling by tractor drawn puddler KT_4

After the harvest of paddy different tillage operations given for wheat crop establishment were :

(I) Ploughing by bullock drawn M.B. plough (RT_1)

(II) Ploughing by tractor drawn cultivator plough (RT_2)

(III) Ploughing by tractor drawn M.B. plough followed by cultivator (RT_3)

Split plot design experiment replicated 4 times with 4x3 treatments. Plots of size 10 x 5 sq.m. each. Wheat (WH-147) was sown during November month. To raise the fertility status of soil a dose of 100 kg-N+60 kg P_2O_5 + 40 kg K_2O per hectare were applied. Other cultural practices were given as per requirement of the crop. Bulk density, penetration force and moisture content at different stages of crop were determined using standard methods.

Results and Discussions

Effect of tillage on bulk density and penetration force

Influence of different tillage operations on penetration force and bulk density (Table 2 and 3) indicate that in all the cases penetration force and bulk density have increased with increasing soil depth.

In case of Kharif treatments penetration force and bulk density were found to be minimum under direct seeded paddy (KT_1) and maximum under tractor puddling treatment (KT_4). In case of *rabi* tillage treatments (KT_1) minimum penetration force and bulk density were recorded under RT_3 treatment and maximum under RT_1 treatment. This trend was maintained for all the three depths. On individual treatment basis, treatment combination KT_4 RT_1 recorded maximum penetration force and KT_1 RT_3 recorded minimum at all the three depths.

Similar results were also reported by Sanchez (1973). He reported that when puddled soils dried, then it shrinked and increased bulk density and soil strength, while deep ploughing reduced the puddling effect. Baver and Kucera (1978) also reported that deep ploughing decreased the penetration force and bulk density and reduced the puddling effect. Maximum depletion has been taken place in puddled treatments and deep ploughing treatment due to more root density and better plant growth in these treatments. Minimum depletion was observed in puddled treatments due to higher bulk density and penetration force which restricted root growth in these treatments.

Table 2 : Effect of tillage on bulk density

Depth cm.	Bulk Density (gms/cc)															
	KT_1				KT_2				KT_3				KT_4			
	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.
0.5-10	1.30	1.28	1.24	1.27	1.31	1.29	1.25	1.28	1.40	1.38	1.33	1.30	1.39	1.38	1.33	1.3
10-20	1.32	1.32	1.30	1.32	1.32	1.32	1.32	1.32	1.44	1.40	1.43	1.43	1.44	1.45	1.43	1.44
20-30	1.43	1.42	1.42	1.42	1.40	1.43	1.43	1.43	1.45	1.45	1.45	1.45	1.46	1.46	1.45	1.46

Table 3: Effect of tillage on penetration force

Depth cm.	Penetration force (kg/cm^2)															
	KT_1				KT_2				KT_3				KT_4			
	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.	RT_1	RT_2	RT_3	AV.
5 cm.	4.93	4.85	3.80	'4.53	5.79	5.47	3.97	5.08	6.14	5.74	5.68	5.85	6.91	6.40	5.76	6.36
10 cm.	6.30	6.09	5.35	5.91	6.81	6.77	5.80	6.46	7.07	7.05	5.95	6.89	7.69	7.76	6.85	7.43
15 cm.	6.94	6.68	6.91	6.84	7.64	7.85	6.65	7.18	7.93	8.35	7.84	8.04	8.69	8.54	8.08	8.44

Effect of tillage on plant growth, root growth and yield of wheat crop

The influence of tillage practices on growth and yield attributes (Table 4) may be due to differential soil-water-air-plant relationship which caused more uptake of nutrients, higher bulk density and higher penetration force adversely affecting the growth of the crop. Phillips and Kirkham (1962) showed negative correlation between yield, bulk density and penetration force. In case of puddled treatments (KT_3 and KT_4) root growth was also restricted due to the higher bulk density and penetration force. The retarded root growth adversely affected plant growth in these treatments. Similar results were also reported by Separe et.al.(1976).

Higher dry matter yield and grain yield in case of unpuddled treatments and deep ploughing can be related to favourable bulk density, better plant growth and yield attributes in these treatments. Similar results were also reported by Sharma et.al. (1971).

Table 4: Effect of tillage on growth and yield of wheat crop

Treatment (kg/ha)	Plant height, cm			No. of tillers		No.of effective tillers	Weight (gm/100 seed)	Grain yield (kg/ha)	Drymatter yield(Kg/ha)
	30 DAS	60 DAS	Harvest	60 DAS	Harvest				
KTI	20.00	48.00	87.50	3.9	4.6	4.1	35	3273	7453
KT2	20.70	46.90	84.80	3.9	4.7	4.2	34	2998	6923
KT3	19.90	43.70	77.00	3.5	4.2	3.2	33	2066	4701
KT4	19.12	43.00	74.60	3.3	3.7	2.9	33	1960	4449
S.EM±	0.30	0.95	5.31	0.17	0.08	0.29	0.30	108	268.0
C.D. 5%	0.97	3.03	1.66	0.59	0.26	1.00	0.96	345	856.6
RTI	20.10	43.40	80.20	3.70	4.2	3.6	34	2390	5453
RT2	19.70	46.30	81.50	3.70	4.4	3.61	34	2612	5963
RT3	20.70	46.50	81.20	3.50	4.3	3.3	34	2721	6229
S.EM±	0.34	0.66	1.27	0.1	6.80	0.12	0.15	86.14	236.6
C.D. 5%	NS	2.29	NS	NS	NS	NS	NS	NS	NS

Table 5: Energy requirement and cost of cultivation of Kharif and Rabi crop

Sl. No.	Particulars	KHARIF (PADDY)				RABI (WHEAT)		
		KT_1	KT_2	KT_3	KT_4	RT_1	RT_2	RT_3
1.	**Time required** to prepare seedbed and sow one ha area							
	a) Pair of bullocks-hr.	33	23	31	23	23	2.8	2.4
	b) Human - hr.	33	248	231	219	23	5.5	6.7
	c) Tractor-hr.	-	-	-	1.5	-	2.7	4.3
2.	**Total energy requirement, MJ/ha**							
	a) Bullocks	328	235	316	235	232	28	24
	b) Human	63	486	453	430	45	10	13
	c) Tractors (Fuel)	-	-	-	267	-	481	765
3.	**Energy Requirement, MJ/ha**							
	a) Tillage operation	281	281	377	551	346	485	775
	b) Tillage+Sowing	392	722	769	933	277	519	804
4.	**Cost of operation, Rs/ha**							
	a) Tillage	380	390	510	590	333	238	320
	b) Tillage + Sowing	513	1198	1319	1399	275	284	419
5.	**Average Yield q/ha**	**38**	**37**	**47**	**51**	**24**	**26**	**26**
6.	**Energy Equivalent, MJ/ha**							
	(a) GRAIN	55904	55227	69780	74764	35133	38396	39866
	(b) STRAW	47537	46962	59337	63575	29875	32650	33900
7.	**Total Energy out put, MJ/ha**	**103441**	**102189**	**129118**	**138339**	**65008**	**71019**	**73766**
8.	**Cost of operation (Rs/q of grain)**	11	26	23	49	13	9	13

Energy and Economics

Energy requirement and cost of cultivation of Kharif and Rabi crop with different treatments including the required time of bullocks, human and tractor use, total energy requirement, energy required per quintal of grain produced and cost of production per quintal of grain are given in Table 5.

The maximum energy requirement and cost of operation for paddy and wheat was obtained in the treatment KT_4 (933 MJ/ha and Rs.1398/ha) and KT_3 (804 MJ/ha and Rs. 419/ha). Therefore, less energy is required in the case of bullock drawn puddling and without puddling i.e. KT_1 , KT_2 and KT_3 for paddy and RT_1 and RT_2 in the case of wheat crop. This result shows that KT_4 and RT_3 required more time and more number of operation than other treatments. Higher output energy and operation cost was observed in K_2T_4 and lowest in RT_2. On the basis of yield and production cost per quintal of grain, KT_4 for Paddy and RT_2 for wheat is recommended.

References

Baver, A., and Kucera, H.L. 1978. Effect of tillage on some physico-chemical properties and annually cropped spring wheat yield. Bull. Agric. Expt. Sta. North Dakota State Univ. 506 : 102.

Chatterjee, B.N., and Khan, S.A. 1978. Growth of wheat establishment with different amounts of tillage after harvest of directed seeded and transplanted rice. Indian J.Agric. Sci. 48 (11) : 654-659.

Phillips, R.E., and Kirkham, D. 1962. Soil compaction in the field and corn growth. Agron. J. 54 : 29-34.

Sanchez, P.A. 1973. Puddling tropical rice soil: Effect of water losses. Soil Sci. 115 : 303-308.

Separe, R.K., Singh, B.P., and Singh, P.N. 1976. Response of wheat to minimum tillage. Indian J.Agron. pp. 165.

Sharma, R.B., Verma, G.P., and Rusell , M.B. 1971. Effect of varying bulk density of surface and sub-surface soil on wheat growth under field conditions. Proc. Int. Symp. Soil Fert. Evan. New Delhi 1 : 519-527.

Yadav, R.S., and Ohja, T.P. 1981. Tillage and energy demands under irrigated regimes, in humid hot regions. Presented in 18th Annual Convention of ISAE held at CSSRI Karnal Feb. 26-28, 1981.

Sharma, D.N., and Jain, M.L. 1989. Evaluation of No-Tillage system in wheat after cotton under light soils. Published in proceedings of the silver jubilee convention of ISAE held at Rajasthan Agricultural University, Udaipur Jan. 5-7, 1989.

CHAPTER 4

Lowtill Farming Strategies for Resource Conservation and Improving Soil Quality in North Eastern Ghats of Orissa

C.R.Subudhi, B. Behera,S.K. Mohanty, H.K. Senapati and D.Jena[1]

Inroduction

Proper tillage operation coupled with organic manure has positive impact on dry land crops.Optimum tillage prevents soil erosion in high rainfall regions and incorporation of stubbles adds more retardation effect to it .Weeds are the major menace to dry land crops and the yield is greatly affected if weeds are not removed in time . So, the effect of optimum tillage with the control of weeds either by use of herbicide or manual need to be qualitatively assessed in relation to the yield as well as the ultimate soil health care. An experiment was designed to assess the impact of minimum tillage and low till system on crop yield.

Material and methods

The experiment was carried out during 1998-2000 (three years) at dry land research farm , O.U.A.T., Phulbani in randomized block design with three replication and eight treatments.The treatments were:

T_1 - Conventional Tillage(C.T.)+Recommended Fertilizer(R.F.)+Hand Weeding(H.W.) without Off Season Tillage (O.S.T)

T_2 - C.T.+R.F.+H.W. with O.S.T,

T_3 - Low Till(L.T.)+H.W. with incorporation of SPC (Stubbles of Previous Crop),

T_4 - L.T.+Hebicide with incorporation of SPC,

T_5 - L.T.+Compost(4t/ha)+H.W.

T_6 - L.T.+ Compost(4t/ha)+ Herbicide,

T_7 - L.T.+Cassia green leaf(2t/ha)+Herbicide,

T_8 - L.T.+ Cassia green leaf(2t/ha)+H.W.

Results

In conventional tillage 2/3 tractor ploughing was made and in low tillage only furrow opening by trench hoe was made after cleaning the weeds.Recommended fertilizer was applied.Soil drainage condition was good.Texture of the soil was sandy loam.Soil depth was 1.5 m and bulk density was 1.63 g cm^{-3}. Rice was grown in kharif. The results of experiments are presented in Table 1. The treatment (T2) registered the highest grain yield of rice(23.9 q ha-1) followed by treatment T1(23.6 q ha-1). More over the yield of these two treatment were significantly higher than all other treatments.The trend was continuously observed for three years.

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Table 1: Yield and yield attributing characters of rice

Treat ment	Grain yield (q/ha)				Straw yield (q/ha)				Plant height (cm)				Length of penicle (cm)				No of effective tillers/sq.m.			
	1998	1999	2000	Mean	1998	1999	2000	Mean	1998	1999	2000	Mean	1998	1999	2000	Mean	1998	1999	2000	Mean
T1	8.02	10.69	23.63	14.11	18.9	24.3	22.1	21.80	61.7	60.6	64.9	62.6	17.3	10.1	17.5	17.3	432	485	341	381
T2	10.22	11.59	23.94	15.28	24.1	26.8	24.1	25.00	67.8	61.1	64.1	64.2	17.2	17.0	16.5	16.6	420	536	425	390
T3	0.96	2.31	4.52	2.60	3.7	6.3	6.7	5.50	45.3	37.6	37.9	40.2	11.1	10.8	12.0	11.3	178	157	259	168
T4	2.09	2.67	6.50	3.75	6.9	7.9	6.8	7.20	49.7	42.1	40.5	44.1	11.9	12.1	12.7	12.2	218	147	338	198
T5	1.33	2.41	7.27	3.67	6.5	7.1	7.7	7.10	45.0	39.0	44.1	42.6	12.2	12.2	13.1	12.5	176	197	331	205
T6	3.87	2.68	9.62	5.39	8.3	8	11.5	9.30	48.9	41.1	43.1	44.4	12.7	11.7	13.3	12.6	250	197	269	197
T7	3.13	2.33	7.71	4.39	6.7	7.4	9	7.70	49.5	46.6	41.8	46.0	11.8	12.6	12.6	12.3	202	180	242	174
T8	1.3	2.2	5.64	3.06	5.1	6.3	9	6.80	39.7	41.9	41.5	41.0	11.3	13.6	12.5	12.5	188	223	252	188
SEm±	0.83	0.96	2.13	0.85	2.12	0.29	2.1	1.16	2.42	3.5	3.3	1.59	0.79	0.9	0.82	0.34	7	19	14	12
CD (0.05)	2.5	2.9	6.46	2.59	6.43	0.88	6.37	3.53	7.35	10.6	9.98	4.82	2.4	2.6	2.49	1.04	21	57	41	35

T1-C.T.+R.F.+H.W. without O.S.T.,T2- C.T.+R.F.+H.W. with O.S.T,T3-L.T.+H.W. with incorporation of SPC,

T4-L.T.+Hebicide with incorporation of SPC,T5-L.T.+Compost(4t/ha)+H.W.,T6- L.T.+ Compost(4t/ha)+ Herbicide,

T7-L.T.+Cassia green leaf(2t/ha)+Herbicide,T8—L.T.+ Cassia green leaf(2t/ha)+H.W.

The moisture content was recorded in two dephs from 0-15 cm&15-30cm which shows that moisture is 18.75 % more at higher depth.

Conclusions

It is concluded that the effect of conventional tillage, recommended fertilizer, off season tillage &herbicide had great impact to increase the yield of the rainfed rice for the first three years.

CHAPTER 5

Mechanization of Plastic Mulching

Anurag Kumar Dubey, U.C. Dubey, A. Patil and P. Gour[1]

Mulching is a practice of covering a layer of material over the surface of soil for providing a favorable environment for plant growth. In some cases additional use of protective covers over the crop to allow for production of crops when production is not normally possible. Plastic mulches have been used commercially on vegetables. Basically three major colours of mulches are used commercially i.e. black, clear and white. Black colour sheet is used most widely because it suppresses weed growth, resulting in less chemical usage. It is also used for cool seasons because it warms the soil by contact. Soils under white mulch remain cooler because of less radiant energy is absorbed by the mulch. Recently efforts are on to develop biodegradable mulches as in Table 1.

Table 1: Biodegradable plastics and their constituents

Product name	Constituent
Micro-organism based	
Biopol	Copolymer of polyhydroxybutyrate and valic acid (PHB/V)
Chemical synthesis based	
Poly Lactic acid	Poly Lactic acid
Pockcelton	Polycaprolactone (~ NH-(CH2)5-C=O ~)
Bionolle	Alphatic polyster
Natural Product based	
MATER-BI	Starch (60%)/PVA alloy
NOVON	Starch (90-95%)+ additive
AMIPOL	Starch (100%)

Plastic mulch laying machine is used for laying plastic sheet on either raised or flat beds. Flexible transparent or semitransparent materials are used to cover a crop to enhance growth and yield by increasing soil and air temperature and also reduce damage caused by wind.

Plastic mulching technology

Generally plastic sheet of 25 micron is used in commercial practice. Plastic mulch can be used in brinjal, tomato, chilly, cabbage, cauliflower, ladies finger, onion, etc. At present plastic mulches are being used for suppressing weeds, moisture conservation and solarization. Mohapatra et.al. (1999) and Kumar et.al. (1998) shown that there was 24-32% increase in yield, when black sheet of 25 micron was used as mulch during winter season in Tomato crop. Cooper (1998) has shown that plant stands were 85-90% in all transplanted crops under plastic mulch. Advantages of using plastic mulch films of different thickness and colours are summarized (Mohapatra et.al. 1999, Kumar 1998) in the Table 2.

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Table 2: Use of plastic for vegetable cultivation

Sl No.	Crop	% Increase in yield	% Weed control	Thickness of plastic used (m)	Colour/type of plastic sheet
1	Brinjal	10	90	25	Black
2	Okra	48	-	-	White
3	Potato	49	32	-	-
4	Tomato	32	-	25	Black

Land preparation

A fine textural bed should be prepared. Fertilizer should be applied and incorporated into soil before formation of beds. The width of bed will depend upon the crop and number of rows desired per bed in case of raised bed. The soil must have adequate moisture at the time of laying plastic sheet and should be free from rocks, clods and un-decomposed plant debris which could puncture the plastic sheet. Soil should be well pulverized and fine textured. For efficient running of plastic mulch laying machine, soil should be friable.

Bedding the soil

With some bedding machine soil is lifted and then compressed to a uniform height and density using bed press pan. While bedding enough soil should be pulled up so that the bed has sharp corners. Bedded rows should be spaced 1.5 to 1.8 m distance depending on the equipment. A bed with a 750 mm top should slope from the center to the edge with a drop of 30 mm, allowing excess rainfall to run off the mulch.

Laying Plastic Mulch

There are the problems in laying of the plastic in the field as on the raised bed and in the form of the tunnel manually. Applying mulch properly in order to realize all the potential benefits of investment, the plastic should be in continuous contact with the soil. Space between the soil and the mulch interferes with heat transfer and prevents the soil from warming and thoroughly. In developed countries, plastic mulch is laid with the help of tractor drawn plastic mulch laying machine. It can lay sheet of plastic mulch either on raised bed or flat beds or row covers. The edges of the mulch should secure with generous amount of soil. However, care should be taken not to apply more soil than is needed, as this makes the mulch more difficult to remove. Many types of the plastic mulch laying machines were developed in other countries. Plastic mulch laying machine is used for laying plastic sheet on either on raised or flat beds and laying low tunnels to cover plant row. American and European mulch laying machines are available with varying features and facilities; ranging from simple plastic film layer machine to machines forming and shaping bunds, laying of drip lines, placement of fertilizers and application of pesticides. Some machines do have facilities for sprinkling water. Plastic mulch is most efficient when used in conjunction with drip irrigation system. A drip tube can be applied on the soil surface under the mulch or buried two or three inches beneath the soil surface.

Planting and Management

Planting through plastic mulch can be accomplished either mechanically or manually, depending upon the size of operation and sources available. Plastic mulch does not eliminate the need for good cultural practice. On the contrary more intensive management is needed to ensure utilization of the mulch to its great advantage. Furrow irrigation along the edge of the plastic can be practiced. Drip irrigation can be adopted for good results so that water-soluble fertilizers can be given through drip system.

After the plastic has served its purpose, it must be removed from the field as soon as possible. No attempt should be made to plough or disc the non-degradable plastic under any circumstances. Disposal of the plastic mulch is a major problem, hence a degradable mulch is most desirable option.

Low tunnels or row covers

Major benefits of row covers are earliness and wind protection. Earliness is greatly attributed to warming soil beneath the cover. Wind protection reduces stress on plants during early growth.

Row covers installed using two sheets of 600 to 750 mm wide anchored on each edge with the soil and fastened together at the top with the Clothespin. Plastic is supported with the iron hoops about 5 feet spacing down the row. Clothespin allow the cover to be ventilated on warm days. A less expensive alternative is a single sheet of plastic about 60 inches wide, stretched over the wire hoops after the crop is transplanted and anchored with the soil each side. Porous, slatted or perforated plastic may be used and additional manual ventilation may also be required if excessive heat is built up.

Low continuous tunnels, made from lightweight polythene film sheet stretched over galvanized iron hoops, pushed in to the ground at about 1m apart. The maximum height of the tunnel is about 330 to 350 mm. The film is held tight over the hoops with the string. Perforations are made on the film at some intervals on leeward side for ventilation watering and other operations.

Advantages of plastic mulching

a) Earliness

Plastic mulch can be used effectively to modify the soil temperature. Black or clear mulch intercept sunlight, which warms the soil. White mulch reflects the sunlight and keeps the soil cooler. Black mulch will warm the soil and promote the faster growth, which generally leads to earlier harvest. Clear mulch warms the soil more than black mulch and usually provides even earlier harvest. Clear mulch, however does not block light, which means weed control beneath the mulch is needed.

b) Regulation of soil moisture

Plastic mulch helps to prevent moisture loss during dry spell and also sheds excessive water away from the root zone during period of excessive rainfall. Thus, this can reduce the incidence of moisture related physiological disorders.

c) Weed control

By using appropriate plastic mulch weeds can be controlled effectively. Black plastic mulch can accomplish this job more effectively. Black plastic mulch prevents light from reaching the soil surface, which in turn prevents most weeds from growing. Clear mulch do not prevents weeds from growing and, in fact, may make their growth more vigorous due to growing environment beneath the plastic.

d) Improved quality

Plastic mulch helps to keep away tomato fruits from contacting ground. This reduces soil rot and keeps the product clean. Properly installed plastic sheet helps to keep away soil from splashing onto the plants during rainfall, which can reduce grading time.

e) Reduced soil compaction

Soil beneath the sheet remains loose and friable. Aeration and soil microbial activities are enhanced.

f) Improved plant growth

A combination of the above and perhaps other factors, result in more vigorous and healthier plants with more resistance to pest.

g) Reduce fertilizer Leaching

The impervious mulch facilitates run off of excess water. Fertilizer beneath the mulch is not lost due to leaching. So, fertilizers are optimally used and not wasted.

Development of plastic laying machine

At present plastic mulching is done manually. It is time consuming, labour intensive and tedious job. Considering these problems plastic mulch laying machine to suit Indian conditions was developed.

Some designs of the machine from Israel, Japan and USA were studied to work out details suiting to Indian conditions. Israel design was adopted and modified. There is a provision for height and width adjustments. There is also provision of bund or raised bed former assembly, roll holders, two press wheels of 300 mm diameter, two transport wheels of 490 mm and two scrapers for covering plastic film roll edges with soil.

Plastic sheets of 25 to 30 micron thickness and up to 1500 mm width could be used in the machine. Dust free and self-centering bearings were used for smooth and trouble free operation of the plastic mulch laying machine even under dusty conditions. Plastic sheet roll is mounted on

Fig.1: Plastic mulch laying machine

two hub pins made of nylon and / or rested on two rollers. Indigenously design machine in operation (Fig.1).

The machine would be capable of laying Plastic sheet either on raised bed or on galvanized iron hoops to form low tunnels over already growing plants. Musk-melon and water melon could be grown in low tunnels for taking early production ahead of the season. Before transplanting the seedlings on bed, hoops are fixed manually at distance of 1 to1.50 m. The width of two hoops is kept 30-40 cm with a height of 0.50 m above the level of the plastic sheet of 30-micron thickness and IR grade plastic partly reflected infrared radiation to keep the temperature of the low tunnel higher than outside. After transplanting, plastic may be covered on the beds with the tractor drawn plastic mulch laying machine. Total cost of low tunnel may come very less as compared to greenhouse or walking tunnel.

Conclusion

Considering the present status of mechanization of plastic mulching in India, a machine has been developed at CIAE, Bhopal suitable for Indian conditions. It would facilitate following benefits (a) Reduce time and drudgery involved in plastic mulch laying (b) The machine can cover 1 to 2 ha per day, depending upon row spacings (c) Capable of laying plastic sheet either on flat or raised bed and (d) Capable of laying plastic sheet on galvanized iron hoops to form low tunnels over already transplanted crop.

Plastic mulch system can produce significant yield increase, if managed properly. With proper planning and careful management to all the cropping sequence, early harvest and higher yields are possible using "intensive" cultural practices.

In India work on plastic mulching is being practiced on very limited scale. Machine has been developed at CIAE, Bhopal for laying plastic mulch and also to lay low tunnels, which will help in popularization of plastic mulch technology on larger scales.

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References

Anonymous 2002 Indo - Israel project at a glance. IARI, New Delhi

Copper P E. 1999. Effect of different plastic mulch colors on yield and qualities of tomatoes. Research Series Arkansas Agricultural Experimental Station. No. 466, 96-97.

Kasperbauer, M J 2000. Strawberry yield over red versus black plastic mulch. Crop Science. 40:1,171-174.

Kumar R; Srivatava BK; Kumar R 1998. Influence of different mulch material on yield and quality of winter tomato. Proceeding of the National Academy Of Science India 68:3-4, 279-262.

Mohapatra B K; Naik P: Lenka D 1999. Efficiency of plastic mulching in tomato. Environment and Ecology. 17:3, 775-776.

CHAPTER 6

Significance of Seeding and Planting Equipments in Enhancing the Productivity of Dry Land Agriculture

Anurag Kumar Dubey [1]

Indian agriculture contributes 25 % to the GDP. Out of total cultivable area of 144 m.ha about 65% is under rain-fed farming, but its contribution to national food grain is only 45%. There has been emphasis for development of technologies for increasing production and productivity of dryland agriculture. Consequent to these efforts, a number of good technologies and equipments were developed at various research centres in the country. However, benefits of these technologies are not reflecting on the ground so prominently. Here is need for extending and popularizing these technologies among the farmers involving local manufacturers, establishing custom hiring enterprises so that the benefits could be extended to marginal and small farmers of dryland areas.

Out of various operations, efficient and timely seeding and planting operations are the most critical to exploit proper soil moisture available for optimum germination and emergence of seeds and subsequent healthy crop establishment. This would be a key to achieve maximum productivity, particularly out of the drylands. An attempt is made here to present and highlight significance of seeding and planting equipment developed for enhancing productivity of dryland agriculture.

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended row to row spacing, seed rate, seed to seed spacing and depth of seed placement vary from crop to crop and for different agro-climatic conditions to achieve optimum yields and an efficient sowing machine should attempt to fulfill these requirements. In addition, saving in cost of operation, time, labour and energy are other advantages to be derived from use of improved machinery for such operations.

Traditional Sowing Methods and Devices

Traditional methods include broadcasting manually, opening furrows by a country plough and dropping seeds by hand, known as `Kera', and dropping seeds in the furrow through a bamboo/ metal funnel attached to a country plough (Pora). For sowing in small areas, dibbling i.e., making holes or slits by a stick or tool and dropping seeds by hand is practiced. Multi-row traditional seeding devices with manual metering of seeds are quite popular. Traditional sowing methods have following limitations;

i. In manual seeding, it is not possible to achieve uniformity in distribution of seeds. A farmer may sow at desired seed rate but inter-row and intra-row distribution of seeds is likely to be uneven resulting in crowding and gaps in field.

ii. Poor control over depth of seed placement.

iii. It is necessary to sow at high seed rates and bring the plant population to desired level by thinning.

iv. Labour requirement is high because two persons are required for dropping seed and fertilizer,

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other than the operator.

v. The effect of inaccuracies in seed placement on plant stand is greater in case of crops sown under dry farming conditions.

vi. During kharif sowing, placement of seeds at uneven depth may result in poor emergence because subsequent rains bring additional soil cover over the seed and affect plant emergence.

Functions of Seed-drills and Planters

The functions of a well-designed seed drill or planter are as follows:

i. Meter seeds of different sizes and shapes;

ii. Place the seed in the acceptable pattern of distribution in the field;

iii. Place the seed accurately and uniformly at the desired depth in the soil; and

iv. Cover the seed and compact the soil around it to enhance germination and emergence.

v. Save time, labour and energy through enhanced work capacity.

Seed-beds for Seeding and Planting

Depending upon climatic and soil conditions, seeds are sown on well-prepared and levelled fields, on ridges, in furrows or on beds. Flat seeding and planting refer to operation when the field being sown/planted is levelled and smooth. Seeds and tubers are planted on ridges either to improve soil drainage due to high rainfall. Seeding in furrows is done in arid regions to conserve soil moisture and improve plant growth. When two or more rows of seeds are planted in beds and separated by furrows, it is known as bed planting. Bed planting helps in conserving soil moisture, avoids soil compaction and promotes plant growth.

Subsystems of Sowing and Planting Equipment

Improved seed-cum-fertilizer drills are provided with seed and fertilizer boxes, metering mechanism, furrow openers, covering devices, frame, ground drive system and controls for variation of seed and fertilizer rates. The major difference in different designs of seed drills/planters is in type of seed and fertilizer metering, furrow openers and source of power.

Seed Metering Devices

Metering mechanism is the heart of sowing machine and its function is to distribute seeds uniformly at the desired application rates. In planters it also controls seed spacings in a row. A seed drill or planter may be required to drop the seeds at rates varying across wide range.

Common type of metering devices used on seed drills and planters are:

i. Adjustable orifice with agitator known as gravity feed.

ii. Fluted roller (standard and with small or larger flutes)

iii. Vertical rotor with cells

iv. Plate with cells (horizontal, vertical, inclined)

v. Cup feed

Furrow Openers

The designs of furrow openers of seed drills vary to suit the soil conditions of particular region. Most of the seed cum fertilizer drills are provided with pointed tool to form a narrow slit in the soil for seed deposition.

i. Narrow pointed reversible shovel type furrow openers of 100 to 200 mm size are used on seed drills in medium to heavy soils for medium to deep placement of seeds, most suited for rainfed farming situations in black soils.

ii. Single hoe or double point reversible shovel type furrow openers are used for placement of seeds at shallow to medium depths in light to medium soil and where soil capping or encrustation problem exists.

iii. Shoe type openers are used in black soil regions. Seeds are dropped through a tube connected to boot at rear of opener for placement at shallow to medium depths. When used on seed cum fertilizer drills or planters a special narrow boot is designed to place seed and fertilizer in soil at same depth but in dispersed bands.

iv. Runner or sword type openers are used on planters for shallow sowing. Soil over seed flows back in furrow during operation and seeds are covered with a leveling bar, chain or by operating a wooden plank behind the drill.

v. Inverted Tee openers are used for placement of seeds under saturated soil conditions in compact and untilled fields. Mostly suited for direct seeding of wheat after harvest of paddy.

Factors affecting seed germination and emergence

Mechanical factors which affect seed germination and emergence are

i. Seed damage during metering;

ii. Non-uniformity of depth of placement of seed;

iii. Non-uniformity of distribution of seed along rows;

iv. Transverse displacement of seed from the row;

iv. Loose and dry soil getting under the seed;

v. Excessive soil compaction above the seed;

vi. Non-uniformity of soil cover over the seed; and

viii. Direct contact of fertilizer with seed in the furrow, beyond permissible limits.

To achieve the best performance from a seed drill or planter, the above factors are to be optimized by proper design and selection of the components required on the machine to suit the needs of the crops. The seed drill or planter can play an important role in manipulating the physical environment in favour of optimum seed germination and emergence.

Under arid conditions the top soil becomes very dry, therefore, the seeds are placed 80-100 mm deep in the furrow. This requires the proper furrow opener. In case of lighter soils, the soil cover over the deep-placed seed should be lightly packed to achieve good emergence by better seed-soil contact. In arid regions, dry seeding with deep placement of seed is recommended because the seeds will germinate only when there is sufficient rainfall or adequate moisture at the seed zone.

The recommended fertilizer placement is 50 mm below and 50 mm from the side of the seed. This is difficult to achieve by a single opener in practice. Use of separate openers and deeper placement of fertilizer in such bands is possible if there is no constraint of available power to pull the machine as well as other operational problems like clogging of tines with clods and trashes. However, animal-drawn or manually operated planters have this limitations in particular. The compromise is achieved by band placement of fertilizer 40-50 mm from the side of the seed at the same depth or below the seeds.

Sowing and Planting Equipment

The tools and equipment developed include manually operated mustard drill, rotary dibbler and seed drills. The tractor drawn sowing equipment include seed-cum-fertilizer drills, ridger planter, broad bed former cum seeder, direct paddy seeder, zero-till-drill, strip-till-drill, roto-till-drill and inclined plate and pneumatic planters. Feature and specifications of these machines are summarized and given in Table 1-4.

Significance and benefits of sowing and planting equipment

Performance evaluations and multi-location feasibility trials have indicated following tangible advantages over the traditional devices / implements as summarized by Raje and Agrawal (1982), Srivastava (1982), Pandey (1997), Garg, et.al. (2002) and Rautaray, et al. (2002) :

i. Sowing in time and saving in labour reduced the cost of sowing operations to the extent as under.

Saving in time	:	50 - 75 %
Saving in cost	:	45 - 80 %
Increase in labour productivity	:	300 - 400 %
Increase in animal productivity	:	200 - 400 %

ii. Proper, uniform placement of seed and fertilizer in desired quantities resulted in better plant stand and higher yields, depending upon field conditions to the extent as under.

Increase in yield	:	5.5 - 100 %
Increase in land productivity	:	5.5 - 100 %

iii. Timely sowing operations increased yield s to the extent of 12 to 78 %.

iv. Precise placement of seed and fertilizer showed 25 to 50 % and 22.5 to 57.50 % increase in yields, respectively. Productivity of these inputs increased by 45 to 100 %.

v. Better seed germination and emergence due to proper soil cover and better seed-soil contact under deficient soil moisture conditions resulted in to higher yields to the extent of 3.3 to 25%.

vi. Drudgery to human and animals reduced to the extent of 50 to 80 %, depending upon number of rows of the drills / planters.

Table 1. : Manually operated seeders - Design features, specifications and performance

Sl.No.	Particulars	Naveen Dibbler	CIAE Rotary Dibbler	CIAE Manual Seeder	PAU Mustard Drill
1	2	3	4	5	6
1.	**Specifications**				
	1.1 Dimensions (lxwxh), m	0.28x0.26x1.06	1.57x0.79x0.68	1.8x0.6x0.95	1.27x1.0x0.52
	1.2 Weight, kg	4	21.5	17	9
	1.3 No. of rows	One	One	One	One
	1.4 Seed metering	Single groove cell roller	6 cell roller	Std. Fluted roller	Narrow fluted roll for mustard & discs for ground nut & maize
	1.5 Power transmission	Lever actuated	Roll over- push type	Direct on drive wheel shaft	Chain & sprockets from ground wheel
	1.6 Seed placement device / furrow opener	Jaw type injector	Jaw type injectors	Shoe type	Reversible shovel
	1.7 Power required	One person	One person	Two	1 or 2 persons
2	**Performance results**				
	2.1 Crop	Maize	Maize	Soybean, maize, green gram, sorghum, bengal gram, wheat, etc.	Mustard, ground nut & maize
	2.2 Depth of placement, mm	35	20	60	30 - 50
	2.3 Field capacity, ha/h	0.028	0.042	0.05	0.05 - 0.10
	2.4 Missing, percent	6	5	-	-
	2.5 Labour reqt., man-h/ha	39	27	40	20 - 40
	2.6 Cost of operation, Rs./ha	150	100	440	200
	2.7 Cost of machine, Rs.	200	500	1,200	650
	2.8 Increase in yield, percent	-	-	10 - 15	5
	2.9 Developed at	CIAE, Bhopal.	CIAE, Bhopal	CIAE, Bhopal	PAU, Ludhiana

Table 2. : Animal operated seed drills - Design features, specifications and performance

S.No	Particulars	Small seed sowing drill	CIAE 2/3 row seed drill & seed cum ferti drills	APAU/HAU Seed cum ferti drills	Camel seed cumferti drills	Seeding attachment to country plough	HAU Mustard Drill
1	2	3	4	5	6	7	8
1. SPECIFICATIONS							
	1.1 Dimensions (lxwxh),m	1.25 x 1.11 x 0.95	0.9 x 0.81 x0.8 & 1.0 x 1.0 x 0.78	1.49 x 0.71 x 0.88 & 1.25 x 1.15 x 0.65	1.25x1.15x0.65	0.60x0.35x0.6	1.06x0.9x0.45
	1.2 Weight, kg	50	40,42,45 & 50	89&90	90	10	40
	1.3 No. of rows	Two	Two/Three	Three	Three	One	Three
	1.4 Seed metering	Vertical cell roller	Std. Fluted roller	Cell Rollers/Std Fluted roller	Fluted rollers	Adjustable orifice with agitator	Cell roller
	1.5 Power transmission	Chain& sprockets from ground wheel	Chain & sprockets from ground wheel	Chain sprockets & dog clutch and Vbelt and clutch	V-belt & clutch from ground wheel	Director from ground wheel	Chain & sprockets from ground wheel
	1.6 Seed placement device/furrow opener	Shoe type	Shoe type	Shovel/shoe type	Shoe type	Plough share	Shoe type
	1.7 Power required	Pair of bullocks	Pair of bullocks	Pair of bullocks	One camel	Pair of bullocks	Pair of bullocks
2. PERFORMANCE RESULTS							
	2.1 Crop	Rapeseed, mustard & pearlmillet	Soybean, green gram,sorghum, bengalgram, wheat etc	Castor, groundnut & sunflower /Raya, bajra, cotton, bengal gram, wheat etc	Guar,bajra,cotton, bengalgram, wheat,maithy etc	Soybean, greengram,sorghum, bengalgram, wheat etc	Mustard
	2.2 Depth of placement, mm	35-75	35-100	40-60	35-100	50-100	50-60
	2.3 Field capacity, ha/h	0.12–0.16	0.065–0.28	0.18-0.24 & 0.10-0.20	0.22-0.25	0.05	0.2
	2.4 Labourreqt, man-h/ha	6-9	4-15	5-6 & 5-10	8-9	20	5
	2.5 Cost of operation, Rs/ha	410-195	110-400	165 & 120	120	500	120
	2.6 Cost of machine, Rs	3500	2500-3500	4500–3000	3000	400	1350
	2.7 Increase in yield, percent	10-15	10-15	20	15-20	17	15-20
	2.8 Developed at	CIAE,Bhopal	CIAE, Bhopal	APAU,Hyderabad & HAU,Hissar	HAU, Hissar	IGFRI, Jhansi& CRIDA,Hyderabad	HAU,Hisar

Table 3. : Animal operated Planters - Design features, specifications and performance

S.No	Particulars	Jyoti multi -crop Planter	CRIDA Planter	TNAU Planter	CIAE Inclined Plate Planter
1	2	3	4	5	6
1. SPECIFICATIONS					
	1.1 Dimensions (lxwxh),m	1.35 x 0.85 x 0.75	0.9 x 0.81 x0.8 & 1.0 x 1.0 x 0.78	1.25 x 1.08 x 0.94	4.2 x 1.3 x 0.9
	1.2 Weight, kg	80	50	60	115
	1.3 No. of rows	Three	(Two/Four)	Three	Three
	1.4 Seed metering	Cell type plastic roller	Inclined Plate for seed (gravity-agitator for fertilizer)	Cup feed type	Inclined cell plates for seed & fluted roll for fertilizer
	1.5 Power transmission	Chain& sprockets and gears from ground wheel	Chain & sprockets from ground wheel	Chain sprockets from ground wheel	Chain, sprockets from ground wheel
	1.6 Seed placement device/furrow opener	Chisel type	Shoe type	shoe type	Shoe type
	1.7 Power required	Pair of bullocks	Pair of bullocks	Pair of bullocks	Pair of bullocks
2. PERFORMANCE RESULTS					
	2.1 Crop	Rapeseed, mustard & pearlmillet	Soybean, green gram,sorghum, bengalgram, groundnut etc	groundnut,maize, cotton, sorghum, bengalgram	Soybean, green gram,sorghum, bengalgram, maize, groundnut, cotton, rapeseed, mustard & pearl millet
	2.2 Depth of placement, mm	30	35 -100	-	35-100
	2.3 Field capacity, ha/h	0.10	0.065 – 0.28	0.19	0.12 – 0.15
	2.4 Missing, percent	2.0	-	-	2
	2.5 Labourreqt., man-h/ha	10	4 -15	5-3	7-8
	2.6 Cost of operation, Rs/ha	250	110 - 400	425	90
	2.7 Cost of machine, Rs	7100	7000 - 11000	10,000	5000
	2.8 Increase in yield, percent	-	10 -15	20	15 -20
	2.9 Developed at	MPKV, Pune	CRIDA, Hyderabad	TNAU, Coimbatore	CIAE, Bhopal

Table 4. : Tractor operated Planters - Design features, specifications and performance

S.No	Particulars	Rota - till drill (Fig.1)	No-till drill	Strip-till drill	Ridger Seeder	CIAE Inclined plate planter	Pneumatic planter
1	2	3	4	5	6	7	8
1. SPECIFICATIONS							
	1.1 Dimensions (lxwxh),m	1.8 x 1.45 x 1.2	1.8 x 0.6 x 1.1	2.29x1.037x1.05	1.80x1.20x0.73	-	1450x2450x1250
	1.2 Weight, kg	250-300	250	250-300	200	-	200
	1.3 No. of rows	Nine	Nine / Eleven	Nine	Four	-	Six
	1.4 Seed metering	Fluted roller	Fluted roller	Fluted roller	Fluted rollers	Inclined plates for seed & fluted roll for fertilizer	Suction type
	1.5 Power transmission	Gear/Chain, sprocket	Sprocket chain drive	Plugged ground wheel for sprocket & chain	Sprocket, chain through ground wheel	Chain, sprockets & bevel gears from ground wheel	Chain & sprockets
	1.6 Seed placement device/furrow opener	Inverted 'T' / Shovel/ Shoe type	Inverted 'T' type	Reversible Shovel type	Ridger and reversible shovels	Hoe type	Shoe type
	1.7 Power required	35-50 hp tractor	35 hp tractor	35-50 hp tractor	35 hp tractor	-	-
2. PERFORMANCE RESULTS							
	2.1 Crop	Wheat	Wheat	Wheat	Gram, bajra raya	Groundnut, maize, sorghum, p.pea	Mustard, sorghum, soybean, cotton, maize,p.pea, maize
	2.2 Depth of placement, mm	20-40	50-60	30-50	50	-	100
	2.3 Field capacity, ha/h	0.18 – 0.25	0.35	0.25 – 0.40	0.75 – 1.0	-	0.5 – 1.0
	2.4 Labourreqt, man-h/ha	-	-	-	2-3	-	1 - 2
	2.5 Cost of operation, Rs/ha	-	-	-	250	480	500
	2.6 Cost of machine, Rs	45,000	15000	35000	10,000	15000	40,000
	2.7 Increase in yield, %	-	-	-	15	-	-
	2.8 Developed at	PAU, Ludhiana	GBPUAT, Pantnagar	PAU, Ludhiana	HAU, Hissar	CIAE, Bhopal	CIAE, Bhopal

Fig.1: Rota till drill

Selection of sowing and planting machines

Different designs of improved seed drills/planters have been developed for sowing of crops. Basic difference in the design of these seed drills is mainly in the type of seed metering mechanism and furrow openers. Therefore, it is essential to select the machine with a metering unit and furrow opener suitable for the crop and soil conditions.

i. For small seeds like rapeseed-mustard a seed drill or planter with vertical roller with cells, inclined seed plate with cells or small grooved fluted roller metering system is recommended.

ii. For medium seeds such as wheat, soybean, safflower and linseed, seed drills with standard fluted rollers are recommended.

iii. For bold seeds like groundnut and castor planters with inclined cell plate or cup feed type metering system are recommended.

iv. Small to medium and irregular shaped seeds are very well metered by pneumatic metering mechanisms. It is possible to drop single, double, triple or more seed per hill at specified distances in a row, depending upon type of plates used.

Conclusion

It may be seen that a number of very good sowing equipments have been developed for meeting different seeds and fertilizer. These equipment have also shown advantages of increased yield, better utilization of inputs, saving of time and energy and reduction of cost of operation. Thus, use of these equipments would considerably and significantly enhance productivity of dryland agriculture.

Scope of Zero-Till Seed cum Fertilizer Drill in Dry Land Wheat Crop Production in Kashmir Valley

Tahir Wahid, Jagvir Dixit and Navin Chandra Shahi[1]

Abstract

Zero till and conventional drills were compared for sowing wheat crop in clay loan and silty clay soil. No till drill saved 77% energy and 72% operation cost although no significant difference in yield was observed. The bulk density of zero-till flat was higher upto 24cm depth. Advantage of early sowing is distinctly demonstrated under zero – tillage system.

Introduction

Wheat sowing by conventional methods require number of operations to prepare a fine seed bed after paddy harvesting. Generally 3 to 4 harrowings are needed to remove and incorporate paddy residues, which consumes time and money of the farmers. In Kashmir valley about 60 – 70% area is rainfed. Due to uncertain and erratic nature of rainfall, most of the farmers are able to grow only one crop i.e. paddy in a year, although potential of growing second crop exists. Short span from paddy harvest to wheat sowing creates uncertainty and delays in operations which result in late maturity & poor yield of wheat crop. The late maturity of wheat crop resulted into delay of paddy transplanting & hence affected the paddy yield. Therefore, zero till hold a promise for success of wheat crop in Kashmir valley.

Material and Methods

The study was conducted in two villages of Baramulla district of J & K state. The objective was to determine the effect of use of Zero – till seed cum fertilizer drill on yield, energy input and cost of operation in wheat crop. The soil texture was observed as clay loam and silty clay. The experimental field was divided into two blocks of 0.1 ha each. In one block, wheat was sown directly without tillage operations by using zero–till seed cum fertilizer drill, while in another block wheat was sown by conventional method (field preparation & sowing with drill). A 9-row tractor drawn Zero-till seed cum fertilizer drill was used for the study as an improved technology over the conventional method of sowing.

NT-CL No-tillage in clay loam **NT-SC** No-tillage in silty clay

CT-CL Conventional tillage in clay loam **CT-SC** Conventional tillage in clay loam

Results and Discussion

The bulk density of the soil in zero–tillage system was greater than that of conventional method up to 24 cm depth of soil profile in both soil types. The bulk density at 24 – 32 cm depth was similar under both the systems.

The average moisture content of 21% in zero-tillage was slightly greater than conventional tillage (20%) at sowing time (Table-1). This was because of 6-days early sowing under zero-tillage

1. Sher-E-Kashmir University of Agricultural Science & Technology-K, Wadura, Sopore (J & K)

system than conventional system. Soil moisture content was noticed almost equal in both the system after 150 days of sowing . But at harvesting stage slightly higher moisture was observed in conventional system (17.25 %) than zero -tillage system (17%). Singh and Singh (1995) observed higher moisture, available during stress periods in zero -tillage.

Table1: Soil moisture (%) during wheat growing season.

Depth (cm)	Sowing time		120 days after sowing		Harvesting Time	
	NT	CT	NT	CT	NT	CT
0-10	22	20	20	20	17	16
10-20	21	20	19	19	17	17
20-30	21	20	20	20	17	18
30-40	21	20	20	20	17	18
Mean	21	20	19.75	19.75	17	17.25

The grain yield and straw yield were almost equal under both the systems. The grain yield was low under both the methods due to damage by birds. More weeds were observed in zero–tillage method, it had a better crop stand than conventional method. This may be due to 6-days early sowing.

Table 2 : Effect of sowing method on energy requirement and cost of operation

Sl. No.	Particulars	Silty Clay		Clay loam		Average	
		NT	CT	NT	CT	NT	CT
1.	Human (hrs/ha)	4.20	12.80	4.38	18.38	4.29	15.59
	Tractor (hr/ha)	2.10	6.40	2.19	9.19	2.14	7.79
2.	Fuel Consumption (lit / ha)						
	a. Tillage	0.00	18.00	0.00	28.35	0.00	23.17
	b. Sowing	6.50	7.10	7.01	6.80	6.75	6.95
	Total	**6.50**	**25.10**	**7.01**	**35.15**	**6.75**	**30.12**
3.	Total energy equivalent (MJ / ha)						
	a. Human Labour	8	25	9	36	8	31
	b. Fuel Consumption	366	1413	395	1979	380	1696
	Total Energy req.	**374**	**1438**	**403**	**2015**	**388**	**1727**
4.	**Specifi Energy (MJ/q)**	**11**	**42**	**10**	**50**	**10**	**46**
5.	Cost of operation (Rs / ha)	630	1920	657	2757	643	2338
6.	**Cost of operation (Rs/q)**	**18**	**56**	**17**	**69**	**17**	**63**

1 Man – hr = 1.96 MJ ; 1 litre diesel = 56.31 MJ

Tillage operation : Clay – loam = 1 harrowing + 1 interculturing

Silty – Clay = 2 harrowing + 1 interculturing

Substantial amount of energy was saved by zero–tillage method of sowing (Table 2). The energy requirement and cost of operation per quintal of grain produced were 4.45 and 3.65 times more in conventional method as compared to zero–tillage system respectively. Dhiman and Sharma (1986) reported that zero–tillage system required least energy (0.56 Kwh/ q of grain) and reduced cost of production (Rs. 2.89 / q of grain) as compared to conventional system (0.69 Kwh/q of grain and Rs. 4.23 /q of grain) respectively.

Conclusions

No till drill is energy efficient and cost effective in clay loam and silty clay soils in Baramulla district of Jammu & Kashmir state.

References

Dhiman, S. D., and Sharma, A. P. (1986). Zero-tillage in wheat crop under heavy soils. Agric. Mech. Asia Afr. Latin Am.(AMA).17(2): 15-16.

Singh, B., and Singh, T.P. (1995). Development and performance evaluation of zero-till ferti seed drill. J. agric. Engg. 32(1-4): 13-23.

CHAPTER 8

Performance Evaluation of Precision Planters for Groundnut on Farmers Field

B. John Wesley, B. Hari Babu, R. Swamy and T. Yellamanda Reddy[1]

Abstract

Performance of CRIDA and AERC planters for groundnut sowing was evaluated on farmers fields for TMV-2 variety. Two planters gave the required and recommended seed rate, plant to plant spacing and optimum plant population. Among the two planters CRIDA planter performed better in the field and prefered by farmers.

Introduction

Groundnut crop is predominentaly rainfed, grown on 8.4 million ha area in India. In Andhra Pradesh it is cultivated in about 2.2 million ha covering the districts of Anantapur, Kurnool, Cuddapah, Chittor, Prakasham, Mahaboobnagar etc., under dryland conditions. In Anantapur district alone, the area is about 7.5 lakh ha mostly in red soils and partly in black soils. The average annual rainfall in Anantapur district is about 600 mm in normal years and 280 to 350 mm in drought prone years.

The normal practice of groundnut sowing is done by a 4-row local drill (gorru) driven by a pair of bullocks at 30cm row spacing. The land holdings are small and land topography is slopy. The traditional practice of sowing is time consuming and laborious. The gorru is provided with a small round hopper with 4 holes connected to furrow with seed tube. One person has to operate and another has to drop the seed through the hopper. Intra row spacing of seed depends upon the skill of the person who drops the seed. The recommended seed rate may or may not be achieved by this method and result in poor yield. Moreover, the time available for the dryland farmers is very limited after rainfall event and all the sowings must be completed with in short time. To over come these difficulties the improved precision planters were tested on the farmers fields in Anantpur district.

Material and Methods

The CRIDA 9-row planter (Fig.1) and AERC 9-row multi crop planter were procured from Central Research Institute for Dryland Agriculture, Hyderabad and Agricultural Engineering Research Center, Pune respectively. The CRIDA Planter was provided with inclined plate seed metering mechanism and AERC planter with cell feed metering mechanism. For each row a separate seed box is fixed and connected to furrow through seed tube. The drive for seed metering is taken from a ground wheel. The depth control is adjusted by support wheels. The planters were field tested in 3 locations, one in Agricultural Research Station, Anantapur and two on farmers fields in venkatapurm village. The sowings were done in one acre plot with each one of the implements using groundnut variety TMV-2 during kharif and rabi 2002. The field data like seed rate, field capacity, plant population and plant to plant distance were recorded.

1. Agricultural Research Station, ANGRAU, Anantapur-515 001

Fig.1: CRIDA - 9 Row Planter

Results and Discussions

The results (Table 1) show that a seed rate of 90 kg/ha and 96 kg/ha were obtained in CRIDA and AERC planters respectively, which is close to recommended seed rate. The plant population recorded 10 days after sowing shows 33 and 34 plants per sq.mt. respectively in the plots sown by CRIDA and AERC planters which matches to recommended plant population of 33 per sq.mt.

Table 1 : Performance details of precision planters:

Sl. No.	Name of the planter	Seed rate (kg/ha)	Plant population	Average Plant distance (cm) (per sq.mt)	Field capacity to plant (ha/hr)
1	CRIDA	90	33	10.23	0.50
2	AERC	96	34	12.50	0.44

The average plant to plant distance obtained as 10.23 and 12.5 cm respectively in the plots sown by CRIDA and AERC planters. The recommended plant to plant distance (10) cm was maintained in CRIDA planter where as in AERC planter the distance was 12.5cm which might be due to mechanism where damage of seed observed in operation. The field capacity recorded as 0.5 and 0.44 ha/hr respectively for CRIDA and AERC planter. In view of the above results it is recommended that CRIDA planter may be used for sowing of groundnut crop by the dryland farmers in Anantpur district.

References

Annual report, 2002-03. NATP, Use of improved tools for mechanization of dryland agriculture. Agricultural Research Station, Anantapur

Mayande, V.M. and H.P.Singh, 2001. Use of improved tools for mechanization of dryland agriculture. Technical brochure of the project of presented during launch workshop of the project, CRIDA, Hyderabad.

Wesley, B.J. 2001.Critical mechanization needs for groundnut based cropping system. Paper presented during the launch workshop of mission mode project at CRIDA, Hyderabad.

CHAPTER 9

Development of Ridge - Furrow Type Drill for Arid Region of India

Harpal Singh and Dinesh Mishra[1]

Abstract

A three row tractor operated seed-cum-fertilizer drill with a provision of seed pressing device was designed and developed for sowing of pearl millet and other leguminous crops in thar desert of Arid Rajasthan. With the use of this seed-cum-fertilizer drill the crop can be sown on slanting surfaces of furrow (300 mm wide at the top and 200 mm deep) while still maintaining its shape and slope. Sowing of crop in this fashion helped conserve run off water in the furrow useful for better growth of the plant by creating a high concentration of moisture in the plant root zone under a very low rainfall (100-420 mm/yr) in the arid region. Performance of the seed drill was evaluated for sowing of pearl millet and cluster bean crops and compared its results with local method of sowing (control). On an average 68% higher grain yield was obtained in case of cluster bean crop compared to control.

Introduction

Arid region of Rajasthan commonly known as "Thar Desert" is characterized by harsh climatic conditions with active dunal activities. The arid region is one of the most leading *Kharif* crops growing region in India (Singhal, 1999). Crop-wise it is the largest producer of many Kharif crops in the country (Anon., 1998). Conservation of moisture both pre and post sowing is important for taking Kharif crops successfully under such fragile ecosystem. Large percentage of Kharif crops fail due to frequently occurring droughts in the region (Singh et. al, 2002). Due to fragile ecosystem rains in arid region often disappear in rainy season for quite long spells resulting in wilting and/or complete failure of crop. The crops in the region are generally sown on flat surface by creating small furrows with the help of tractor drawn seed drill provided with tyne type furrow openers and attached with planker to cover the seed (Singh et. al, 1998). There is very little scope to conserve rain water in this fashion of sowing. The crop generally fails due to moisture stress owing to non occurrence of rains for long spells of time which is common phenomena in the region. Under the situation, the farmers are compelled to provide life saving irrigation to a limited portion of the cropped area with their very limited source of irrigation water. Thus, area under crops reduced drastically resulting in lower production and productivity.

Some efforts were made at HAU, Hissar for development of seed drill for sowing of crop on ridges whereas furrows created on both sides of ridge help flow of irrigation water. The sowing of crop in this fashion (Fig.1) helped saving in irrigation water by 40-50% and 10% higher grain yield (Kushwaha, 2001). It was presumed that the sowing on ridge sides will help in conservation of rain water in the furrow and create high moisture concentration in the plant root zone. Therefore, a tractor drawn ridge-furrow type 3-row seed-cum-fertilizer drill was designed and developed. The details of the seed drill and its performance compared to local method of sowing of cluster bean crop is discussed.

1. Central Arid Zone Research Institute (CAZRI), Jodhpur – 342 003.

Material and Methods

Ridge furrow type tractor drawn 3-rows seed-cum-fertilizer drill specifically designed and developed for sowing on slanting surfaces of a furrow with a view to conserve rain water (Anon.1999) was evaluated for sowing of clusterbean crop during Kharif season of year 2001 at the CAZRI's Experimental Farm, Jodhpur (Fig.2).

The experiments were conducted for sowing of clusterbean crop using the local sowing device and the ridge furrow seed-cum-fertilizer drill both with and without use of fertilizer (DAP). Recommended dozes of seed and fertilizer were used. Plot size of 20 x 5 m was taken for each treatment with three replications.

Results and Discussion

The results for clusterbean crop (Table 1) indicated that the ridge-furrow seed-cum-fertilizer drill faired better compared to control even with less number of plants (15 / m^2 in case of ridge-furrow system of sowing and 25 / m^2 in case of control).

Table 1 : Performance of ridge furrow seed-cum-fertilizer drill for sowing of clusterbean crop.

Sl. No.	Number of plants per plot		Average height of plants (cm)		Average number of plants per m		Dry weight of straw g/plot		Grain weight per plot g/plot		Yield, (kg/ha)		Grain to straw ratio %	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b
1.	12	28	0.68	0.52	4	4	200	200	20	10	200	100	10.0	5.0
2.	15	25	0.70	0.48	4	3	200	180	17	8	170	80	8.5	4.4
3.	14	23	0.65	0.65	3	2	150	150	15	8	150	80	10.0	5.3
4.	16	27	0.52	0.40	2	2	190	200	12	12	120	120	6,3	6.0
5.	18	22	0.62	0.45	4	3	220	120	20	12	200	120	9.1	10.0
Av.	15	25	0.63	0.50	3.4	2.8	192	170	16.8	10	168	100	8.8	6.1

a: Ridge furrow seed ferti drill; b: Local sowing method

On an average 68% more yield of clusterbean grains was obtained in case of crop sown using ridge furrow seed-cum-fertilizer seed drill compared to control. It was observed that slightest of runoff water, even with very low rainfall intensity, accumulated in the furrow, which created high

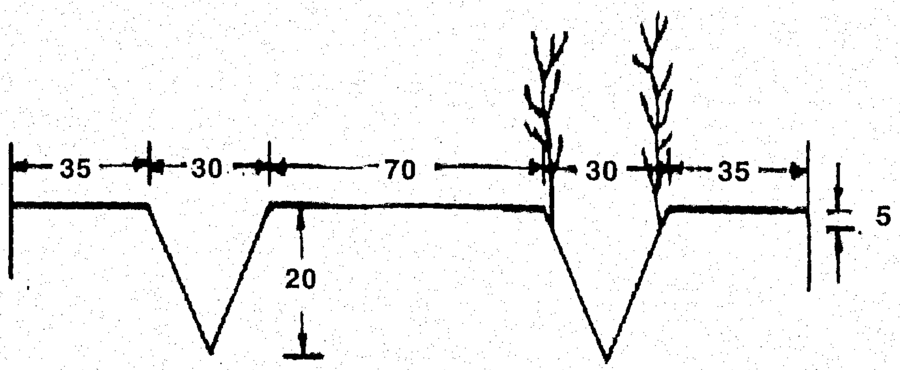
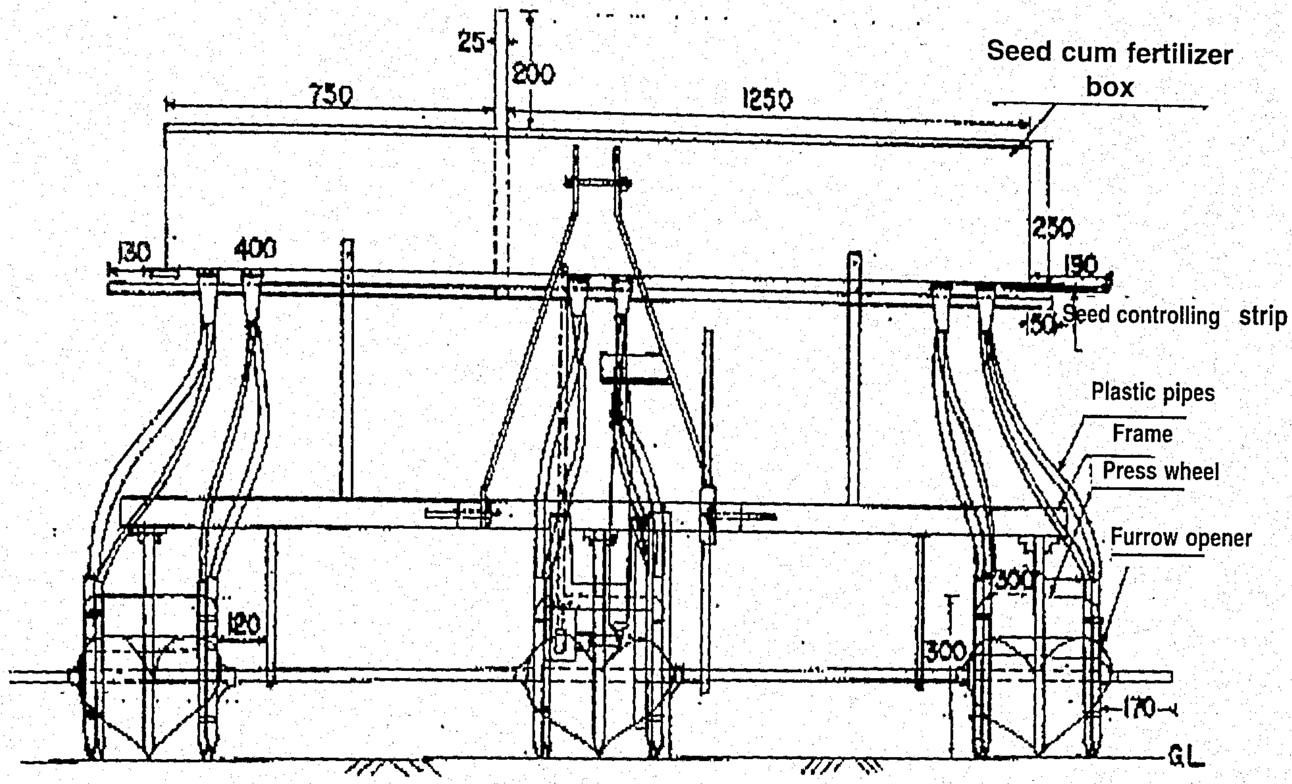
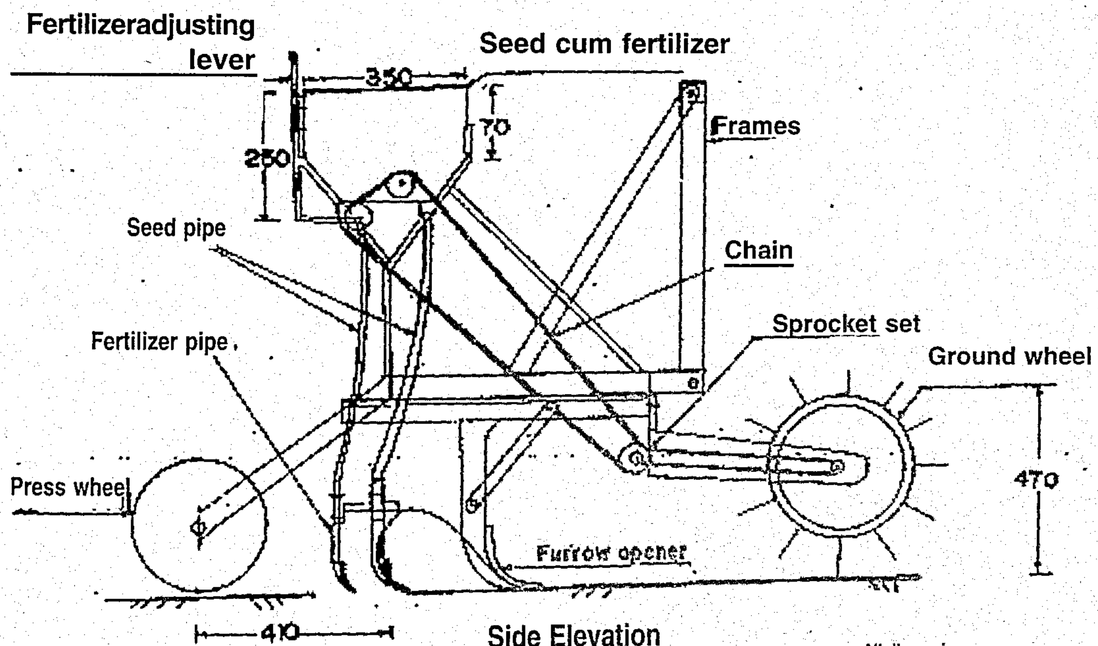


Fig.1: Suggested method of sowing of Kharif crops under highly scarce rain fall region of Thar Desert



Front Elevation



Side Elevation

All dia are in mm

Fig.2: Tractor drawn three rows ridge-furrow type seed-cum-fertilizer drill

moisture concentration in the plant root zone, has resulted in better plant growth and higher crop yield. Further, plant growth remained un-affected even during long dry spell at fag end of monsoon season of the year 2001, whereas in case of control the crop growth was adversely affected due to moisture stresses.

References

Anonymous, 1998. Agricultural Statistics of Rajasthan, Directorate of Agriculture, Pant Krishi Bhawan, Jaipur, pp:37.

Kushwaha, S.S., 2001. Maind Per Gahun Kee Kheti Kee Navintam Taknik Se Buvai Per 40% Sinchai Pani Kee Bachat (In Hindi). Office of the Joint Director, Agriculture, Shreeganganagar (Raj.). Personal Communication.

Singh, H., Mishra, D., and Khan, M.A. 1998. Status of Farm Mechanization in Rajasthan, CAZRI, Jodhpur, pp:443-453.

Singhal, V., 1999. Indian Agriculture, Indian Economics Data Research, New Delhi.

Singh, H., Mishra, D., and Nahar, N.M. (2002). Energy Use Pattern in Production Agriculture of a Typical Village in Arid Zone, India, Part-I. Energy Conversion and Management, Elsevier Science Pub. – Pergamon. 43:2275-2286

CHAPTER 10

Performance Evaluation of Tractor Drawn 6 Row Inclined Plate Planter in Jabalpur Region

Atul K. Shrivastava, S.K. Jain, Alok K. Dubey and V.C. Singh[1]

Abstract

One of the factors for enhancing the productivity is proper placement of seed and fertilizers at recommended row to row and seed to seed spacing. The tractor drawn 6 row inclined plate planter that provide line sowing and required plant population was evaluated in university research farms and near by villages of Jabalpur district on an area of 7.8 ha for mustard, safflower, gram, vegetable pea and lentil crops respectively. Field coverage of machine was 0.58-0.62 ha/hr and field efficiency was 71-76%. The cost of operation ranged between Rs. 316-350 per ha. The planter saved 12-14% in operation cost.

Introduction

Placing the seeds at recommended row to row spacing, plant to plant spacing and at proper depth increases crop yield. The commercial seed drills available in the market have fluted roller type seed metering mechanism, which is not suitable for small and bold seeds. Shrivastava and Patel (2002) reported, that field capacity of bullock drawn inclined plate planter was 0.11-0.14 ha/h for different crops and field efficiency in the range of 69 to 72%. Patel et al. (2002) reported that field capacity of CIAE tractor mounted pneumatic planter was 0.27-0.50 ha/hr. They also observed that seed rate under field trials was lower than recommended seed rate due to uniform spacing of seeds. The cost of operation and initial cost of machine was comparatively higher. A study was undertaken to evaluate a 6 row tractor drawn inclined plate planter in Jabalpur region under vertisol to observe the feasibility of machine for sowing small and bold seeds.

Material and Methods

A 6 row tractor mounted inclined plate planter (Fig. 1) was used for the study. The total area of 7.8 ha was undertaken in university farms and nearby four villages at farmers' field. The test area of 0.313 ha was under mustard, 1.75 ha under safflower, 2.0 ha under gram, 2.75 ha under vegetable pea and 1.0 ha under lentil crops. The machine under test had overall dimensions of 2500 x 1215 x 1010 mm. The various parts of machine were box section frame with a rear tool bar for mounting furrow openers, seed metering device made up of inclined plate with edge cells, drive mechanism and power transmission assembly. The inclined plate planter was facilitated with arrangement for changing row spacing in the range of 22.5 to 45.0 cm by sliding the furrow openers on rear tool bar of mainframe. The six seed hoppers each of capacity 15 kg with independent metering mechanism had two compartments for storing the seed and for picking by inclined plate seed metering plates. The power was transmitted from spiked ground wheel of 400 mm and tip diameter 550 mm through a small counter shaft, main drive shaft to individual seed box for operating seed metering mechanism. Chain and sprockets coupled with bevel gears were used at various stages

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for power transmission. The transmission ratio was 1:1 that could be changed as per requirement. The planter was used for various crops by selecting suitable seed plates and changing transmission ratio. Lifting the planter by tractor hydraulic system performed the operation of seed cut off as ground wheels stops revolving.

The multicrop planter was firstly calibrated for seed by providing 20 revolutions to ground wheel. Later on the field evaluation was performed. During test, mechanical and agro engineering properties were determined viz. seed rate, width of operation, depth of sowing, soil moisture, field capacity, field efficiency, seed spacing and plant population. The labour requirement was found out and finally cost of operation was calculated. The inclined plate planter was compared with conventional tractor drawn seed drill.

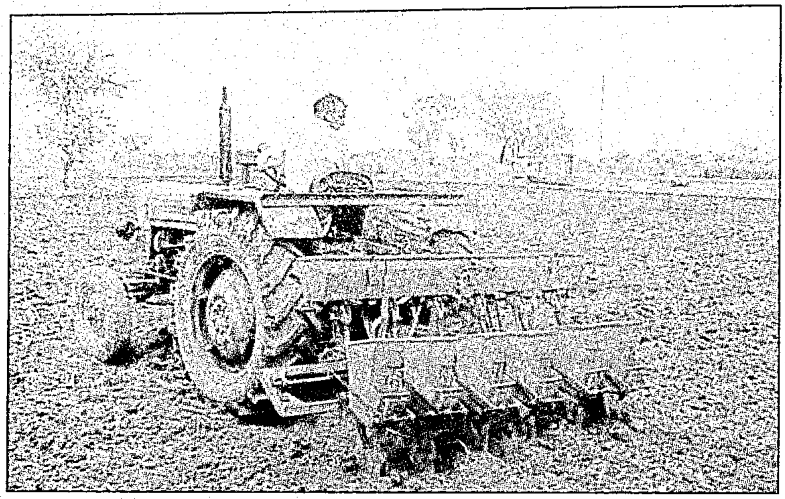

Fig.1: CIAE - 6 Row inclined plate planter

Results and Discussion

The results drawn from calibration of planter are presented in Table 1 for different crops. Three replications were carried to get an average seed rate in kg/ha. It shows that there was 1.33 and 0.92 per cent mechanical damage after calibration for mustard and safflower while other three crops do not had any such damage. Internal injury of seeds after calibration was found to be 1.0, 1.53, 0.98, 0.53 and 0.87 per cent in lentil, mustard, safflower, vegetable pea and gram respectively.

Table 1: Calibration of seed metering mechanism of inclined plate planter

Particulars	Mustard	Safflower	Vegetable pea	Gram	Lentil
Seed rate (kg/ha)	5	12	50	80	30
Mechanical damage, %	1.33	0.92	Nil	Nil	Nil
Internal injury %	1.53	0.98	0.53	0.87	1.0

Table 2: Results of field evaluation of 6-row tractor operated inclined plate planter

Item	Item	Crops				
		Mustard	Safflower	Vegetable Pea	Gram	Lentil
1	Variety -Bold	Pussa	JSF-1	Erkil	Radhe	Jawahar-2
2	Area covered, (ha)	0.31	1.75	2.75	2.00	1.00
3	Av. Depth of Sowing, (cm)	3.5	5.0	4.0	5.0	5.0
4	Av. Row spacing, (cm)	30	35	35	35	35
5	Av. Speed, (km/hr)	3.58	3.50	3.45	3.45	3.44
6	Av. Field capacity, (ha/h)	0.62	0.58	0.59	0.58	0.58
7	Av. Field efficiency,(%)	76	71	75	75	73
8	Av. Seed rate, (kg/ha)	5	13	51	80	30
9	Av. plant population,(pl/m$^{2)}$	5	12-15	15-17	10-12	9-11

The field evaluation of the planter for different crops is presented in Table 2. Results indicated that the field capacity of planter was 0.62 ha/h, for mustard, 0.58 ha/h for safflower, 0.59 ha/h for vegetable pea, 0.57 ha/h for gram and 0.58 ha/h for sowing of lentil crop. Field efficiency of planter was in the range of 71% to 76% . The average seed rate in the field was optimum for all crops under study.

The average speed of operation was 3.48 kmph. Average plant spacings were 19 cm for mustard, 17 cm for sufflower, 18 cm for vegetable pea, 8 cm for gram and 11 cm for lentil. The plant population obtained in the case of mustard, safflower, vegetable pea, gram and lintel was 5, 13, 16, 11 and 18 plants/m^2 respectively.

Table 3 : Comparison of 6 row inclined plate planter and conventional tractor drawn seed drill

Particulars		Mustard	Safflower	Vegetable pea	Gram	Lentil
Yield, Kg/ha	Planter	1240	977	1054	1340	940
	Seed drill	1123	859	886	1259	855
Cost of operation, Rs./ha	Planter	322	340	340	344	342
	Seed drill	370	394	397	399	389

The cost of operation and crop yields (Table 3) obtained by inclined plate planter were compared with seed drill. The results show yield increase of 7-16% in different crops and reduced operation cost by 12-14%.

Conclusions

The functional performance of different system of planter was satisfactory during laboratory and field trials. Planter can be successfully used for sowing mustard, safflower vegetable pea and lintel crop. There was very little or no damage of seeds during operations. The field capacity was 0.57 to 0.62 ha/h. Planter gave fairly uniform plant to plant distance. The yield increase and savings in the cost of operation for different crops indicate that planter contributes in incresing profitability of these crops.

References

Anonymous, 2000. Annual report. Central Institute of Agril. Engineering, Bhopal.

Patel, A.S., Shrivastava A.K., and Nilatkar, D.K. 2002. Annual report of Jabalpur Centre presented in XXIV workshop at Tamil Nadu Agricultural University, Coimbatore.

Shrivastava, A.K., and Patel, A.S. 2002. FIM Annual report of Jabalpur Centre presented in XXIV workshop at Tamilnadu Agricultural University, Coimbatore.

CHAPTER 11

Design and Development of a Drum Type Onion Seeder for Dry Land Cultivation

S.C. Mandhar, A. Carolin Rathinakumari and R. Veere Gowda[1]

Abstract

Onion seeds are generally sown in nursery and seedlings are transplanted to get the optimum yield, however, most often farmers broadcast the seed to save the labour resulting in poor yield due to unequal distribution of seeds which affects the size of the onion bulbs. A drum type onion seeder was developed for small and marginal farmers for growing onion under dry land condition. It consisted of a seed drum which could sow the seeds at 80 mm X 60 mm spacing, wheels, single pointed shovel type furrow openers, furrow closer and handle. The field capacity of the seeder was 0.09 ha/h and cost is Rs. 300/ unit. The yield of onion crop was increased by 40% against the conventional broadcasting method and saved time upto 73%. The onion crop raised by using the drum seeder showed better results in terms of uniform crop stand and quality of the bulb compared to the broadcasted method.

Introduction

Onion is one of the main vegetable crops in India with 4.9 lakh hectares under cultivation (1999-2000), out of total area of 59.9 lakh ha under vegetable cultivation. The export of onion was 2.3 lakh tonne and the export earning was Rs. 202.7 crores during 1999-2000 while the export earnings of the other vegetables was only Rs. 144.2 crores (Anon, 2001). In India Karnataka state is having the largest area of 1.3 lakh ha under onion cultivation with a production of 5.9 lakh tonnes and lowest productivity of 4.7 tonnes per ha. Ideally the onion seeds should be sown in nursery and transplanted with 15 cm row to row spacing and plant to plant spacing of 10 cm to get optimum yield. It requires about 80 to 100 man-days to transplant one ha of onion as 6.7 lakhs seedlings per ha are to be transplanted. The onions are grown in kharif and rabi season in Karnataka and it is mostly under rainfed condition. The onion seeds are broadcasted to save the labour and the yield of around 4.7 tonnes per ha is obtained. The poor yield is recorded due to non-uniform spacing of seeds which also affects the size of the onion bulbs. The seed requirement is 8kg/ha for broadcasting in comparison to 4 kg/ha for transplanting.The onion seeds are also drilled by tractor operated wheat/ ragi seed drills in some of the areas to reduce the requirement of labour. However the cost of operation is very high. Hence a manually operated drum type onion seeder was developed for small farmers who practice dry land farming of onion under dry land cultivation.

Methodology

Seed size and geometry

In order to design the hole size for dropping onion seeds, geometry of seeds was studied. The 100 seeds were selected randomly and the seed dimensions viz., length, width and thickness were recorded using digital vernier caliper with L.C. 0.01 mm. The weight of 1000 seeds was also recorded by using digital weighing balance with L.C of 0.001gms.

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Design of drum seeder

The seeder consisted a frame of size 600 mm X 300 mm, a PVC drum of 90 mm dia. and 580 mm length was fitted in between two side wheels having 250 mm diameter. Holes of 3 mm size were drilled on the drum seeder in 7 rows with spacing of 80 mm (plant to plant spacing). To achieve 60 mm spacing between seeds, the holes were drilled along the circumference at a spacing of 27 mm. Five partitions were made inside the seeder drum between the rows to avoid accumulation of seeds to one side of the seeder drum. The entire assembly was attached to the front end of the frame to allow rotation of drum, while seeder was pulled in forward direction. Single pointed shovel type furrow openers were fitted to the frame in front of the seeding drum. A handle of 1500 mm length and 40 mm dia. was attached to the seeder for easy pulling.

Laboratory testing

A white colour sheet (2m x 5 m) was spread on the ground. Seeds were filled in the drum and it was pulled on the sheet in forward direction. The speed of operation was optimized to get the required and uniform seed distribution. The seeds were dropped on the sheet and number of missings, singles, multiples and distance between seeds were observed.

Field testing

The seeder was tested at IIHR farm during December 2001 to study the field capacity of the seeder, seed rate and yield parameters in comparision to the conventional broadcasting method (Season-Rabi, Variety Arka niketan). The crop was harvested during April 2002.

Results and Discussion

Seed size and geometry

The onion seeds were of triangular in shape. The seed had average base width of 1.9mm, height 2.7 mm and thickness 1.7 mm (Table 1). As maximum dimension of onion seed was 2.7 mm, holes of 3 mm diameter sizes were drilled on the seeder drum to drop single seed while rotating the drum.

Table 1: Characteristic parameters of onion seeds used for testing onion drum seeder

Sl.No.	Characteristic	Parameters
1	Weight of 1000 seeds	3.5 g
2	Shapes	Triangular
3	Base width	1.9 mm
4	Height	2.7 mm
5	Thickness	1.7 mm

Performance of onion drum seeder

It was observed that there was 0% missing, 95% singles and 5% multiple droppings (Table 2) during laboratory study. The average distance between seed to seed was 40-60mm and row to row distance was 80 mm.

Table 2: Seed metering characteristics of drum type onion seeder during lab study

Trials	Percentage of		
	Singles	Multiples	Misses
1	95	5	0
2	93	7	0
3	95	5	0
4	96	4	0
5	95	5	0

Field study was conducted by sowing the onion seeds both by conventional broadcasting and using the drum type onion seeder. It was observed that the average distance between seed to seed was 4-6 cm and row to row distance was 8 cm. It was found that the seed rate for onion was reduced by 50% i.e from 20 kg/ha (conventional broadcasting) to 10 kg/ha (drum seeder). It was also observed that there was 40% increase in marketable yield i.e the yield from the plot (drum seeder sown) was 25 tonne/ha against the plot (conventional broadcasting) 18 tonne/ha. It was observed that the average onion bulb diameter and weight were 45 mm and 64 g in machine sown plot against the 26 mm and 18 g in broadcasted plot respectively (Table 3). The field capacity of the drum seeder was 0.09 ha/h against 0.025 ha/h by broadcasting method. Hence the onion drum seeder saved time upto 73%. The cost of seeder is Rs. 300/-.

Table 3: Yield parameters of onion bulbs sown by broadcasting and drum seeder

Sl.No.	Yield Parameters	Machine sowing	Broad casting
1	Average bulb diameter (mm)	45	26
2	Average bulb height (mm)	47	23
3	Average bulb weight (gm)	64	18
4	Marketable yield (t/ha)	25	18
5	Unmarketable yield (t/ha)	1	21

Conclusion

A drum type onion seeder having field capacity 0.09 ha/hour for dry land cultivation was designed and fabricated. The cost of seeder is Rs. 300/-. The crop raised by using the drum seeder showed better results in terms of uniform crop stand and quality of the bulb compared to the broadcasted method. The seed rate was reduced by 50%, the yield was increased by 40% and time saving was upto 73% by seeder as compared to conventional broadcasting method. Hence the drum type onion seeder is an appropriate implement for small and marginal farmers for growing onion in large areas under dry land cultivation.

References

Anon, 2001, Indian Horticulture Data Base. National Horticulture Board. Ministry of Agriculture, Government of India, Gurgaon, India.

CHAPTER 12

Precision Planter for Dryland Crops

G. Senthil Kumaran[1] and V.J.F.Kumar[2]

Introduction

The productivity in dryland could be increased mainly by introducing high yielding varieties and adopting more stringent resource management practices in farming. The most important agronomic practice that can enhance productivity in the drylands is through maintaining required plant population. At present, the desired plant population is achieved by sowing the seeds in excess per unit area and thinning the crop after germination. This process is labour intensive and costly seeds are wasted thereby increasing the total cost of production. Farm mechanization especially the introduction of precision planting machinery will alleviate these problems apart from enhancing plant yield through better plant spacing management. Hence a vacuum precision planter suitable for planting cotton was developed which can also be used for dryland crops.

Methodology

The vacuum precision planter was designed to singulate the seed by the vacuum pressure supplied to a nozzle. The nozzle was made to oscillate to singulate the seed from the seed hopper and to drop it in a furrow through a suitable four bar mechanism. It consisted of a main frame, vacuum pump, depth control wheels, a common tool bar and a vacuum planting unit (Fig.1). The vacuum planting unit was made as a separate entity consisting of seed singulator, furrow opener, closer and seed hopper (Fig.2.)

Seed singulating mechanism

Seed singulating nozzle meant for cotton seeds was fabricated based on the optimized nozzle parameters (Senthil Kumaran, 2002). The nozzle was screwed on top of a 50 mm diameter and 20 mm thick solid disc. The inlet pipe from the vacuum pump was fitted 15 mm above the centre of this disc. The nozzle and the pipe were inter connected by a 4 mm diameter air duct. The disc with this arrangement was firmly fixed at the centre of a shaft. One end of the shaft was extended 50 mm out of the frame to transmit the drive from the ground wheel. The assembly was so mounted on the frame that it facilitated the movement of the seed singulating nozzle over the furrow. A four bar linkage mechanism as shown in Fig.2 was designed to oscillate the nozzle between the seed hopper and furrow opener for singulating and dropping the seed.

Field testing

The performance evaluation of the planter was tested in the field for singulated seed sowing of cotton. A field of size 0.20 ha was prepared to fine tilth for each crop. The nozzle for cotton seed was fitted and cotton seeds were filled in the seed hopper. The furrow opener and the depth control wheels were so adjusted to have a planting depth of 25 mm. The tractor was operated at the speed of 1.25 - 1.5 km/h for cotton . The row spacing was adjusted to 750 mm. After germination, the plant to plant spacing was observed randomly to a length of 3 m at 30 locations to analyze the

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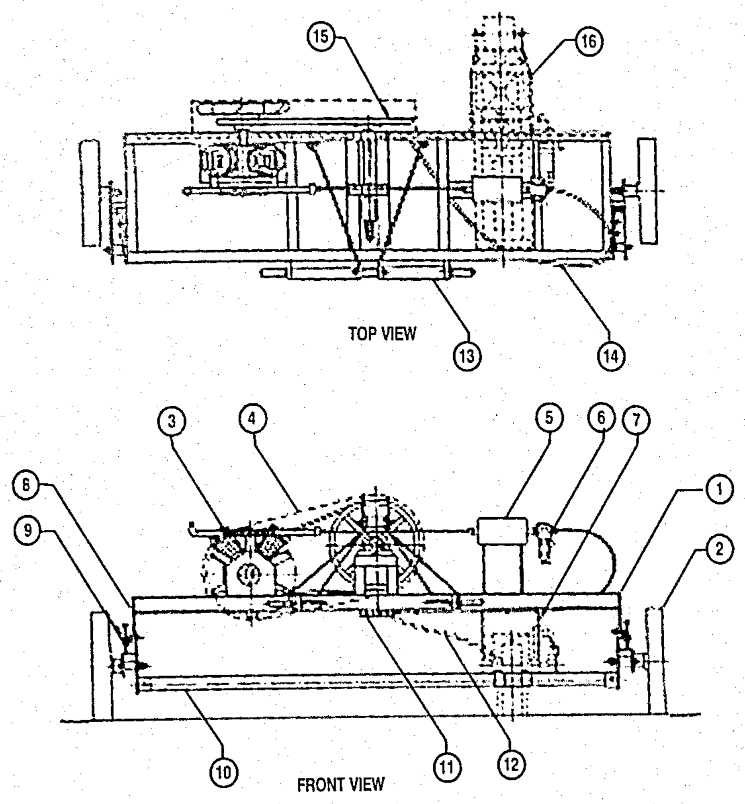

Fig.1: Precision Vacuum Planter

Sl. No.	DESCRIPTION
1.	MAIN FRAME
2.	DEPTH CONTROL WHEEL
3.	VACCUM PUMP
4.	COVER
5.	PRESSURE STABILISING CHAMBER
6.	AIR FILTER
7.	SUPPORT CHAIN
8.	TRAPEZOIDAL VERTICAL PLATE
9.	DEPTH ADJUSTING SCREWS
10.	SEED SINGULATOR MOUNTING PIPE
11.	VACCUM DISTRIBUTION BOX
12.	6MM NYLON TUBE
13.	THREE POINT HITCH
14.	12MM NYLON TUBE
15.	POWER TRANSMISSION
16.	PLANTING UNIT

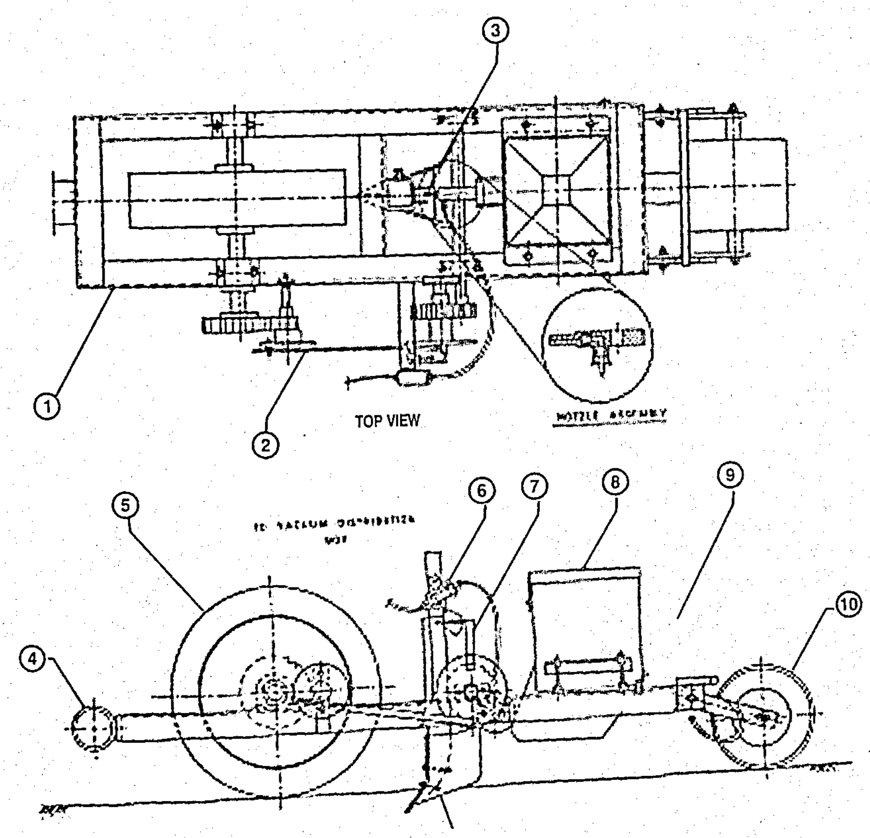

Fig.2: Four bar linkage mechanism

Sl. No.	DESCRIPTION
1.	FRAME
2.	FOUR BAR MECHANISM
3.	NOZZLE
4.	HITCH BUSH
5.	GROUND WHEEL
6.	BALL VALVE
7.	VALVE OPERATING LEVER
8.	SEED HOPPER
9.	SUPPORT CHAIN
10.	PRESS WHEEL
11.	FURROW OPENER

distribution of plant spacing. The number of multiples were also noted. From the observations, miss index, multiple index, quality of feed index and precision were calculated (Anon, 1984 ; Kachman and Smith, 1995).

Results and Discussion

Field testing of the planter

The planter was tested at 1.25 - 1.5 km/h in the field for planting cottonseed having viability of 65 percent. As explained above, the performance indices namely miss index, multiple index, quality of feed index and precision for the plant spacing obtained were calculated and summarized in Table 1. The performance indices indicated that quality of feed index was about 76 per cent for cotton and the precision obtained was about 23 per cent. The performance inferred that these data was influenced by plant germination (seed viability) apart from the planter performance. Since the viability of the seeds used was around 65 per cent only, a number of misses in plant spacing had influenced the performance indices. If the viability of the seed is improved, the performance of the precision planter will also be improved.

Table 1: Performance indices of the planter for cotton

Mean Spacing (cm)	31.87
Standard deviation (cm)	16.74
Multiple index (%)	7.69
Miss index (%)	16.35
Quality of feed index (%)	75.96
Precision (%)	22.67

Cost economics

The field capacity of the vacuum precision planter with 4 rows was 0.36 ha/h. The cost of operation was Rs.649 per ha. The cost saving over conventional planting was about 35 % and time saving was about 55 - 65 %.

References

Anonymous, 1984. Sowing Equipment - Test methods - Part I: Single Seed drills (Precision Drills), 7256/1. International Standardization Organization Geneva Switzerland: ISO.

Kachman, S.D., and J.A.Smith. 1995. Alternative measures of accuracy in plant spacing for planters using single seed metering. Transactions of the ASAE,.38(2):379-387.

Senthil Kumaran, G. 2002. Investigation on vacuum seed singulating nozzle parameters towards developing a precision planter, Unpublished Ph.D. thesis, Department of Farm Machinery, Tamil Nadu Agricultural University, Coimbatore -641 003.

CHAPTER 13

Implements for Moisture Conservation and Sowing in Dry Farming

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Introduction

Crop production in drylands is dependent entirely on natural precipitation, which is highly undependable in terms of onset, recession and distribution during the crop growing season. As the productivity of irrigated agriculture has been stagnant, rainfed farming would inevitably has to be relied upon in future. This demands a greater role from scientists and extension specialists to divert more attention towards dryland agriculture, where there is larger scope for increasing the food production. Rainfall is the only source of water for these lands and hence it is necessary to maximize its retention. The first step in land-use planning is to provide for the maximum retention of water / rain that falls on the land. This means as much percolation of rainfall as possible in soil where it falls, controlled removal of excess rainfall and protection of the soil. It is to be emphasized that conservation and optimization of the use of rain water so that it stays in the soil profile for long periods and is released slowly for the use of crops, become important steps for improved dryland farming. Such utilization of rainfall is accomplished through the correct cultural practices and certain engineering structures.

Moisture conservation techniques at micro-level advocated are vegetative barriers, ridges and furrows, broad bed and furrows, tie ridges etc. Due to the labour scarcity and cost of labour, these practices are not being adopted and hence development and use of implements becomes necessary. In addition, the subsoil hard pan is to be removed. To overcome these problems and to conserve soil moisture the following implements were developed and evaluation trials were conducted in problem soils and in different parts of dry farming areas.

I. Chisel plough

Deep tillage using chisel plough is essential for improving the yield of crop especially under dry farming. Deep tillage shatters compacted sub soil layers and aids in better infiltration and storage of rainwater in the crop root zone. The improved soil structure also results in better development of root system and the yield of crops and their drought tolerance is also improved. Summer fallow ploughing using chisel plough prepares the field for better uptake of rain water and soil erosion is minimized. Deep tillage requires high draft requirement especially when the soil is dry and in a state most favourable for chiseling. Deep tillage is not practiced in India due to the unsuitability of the existing deep tillage tools for operation with 35-45 hp tractors.

The developed implement has a sturdy but light structure made of 3 mm thick hollow rectangular tubular mild steel sections. The frame has been designed based on computer analysis of the structure to ensure its strength. The implement is simple in construction and has only three components viz. frame, standard and share. The share has a lift angle of 20 degree, width of 25 mm and a length of 150 mm. The implement is protected by a shear pin which prevents damage from over loading. The implement could be used for deep tillage upto a depth of 40 cm.

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The coverage is 0.42 ha/hr when operated at a spacing of 1.5 m between rows. The salient features of the unit are:

- The implement could be used for deep tillage upto a depth of 40 cm for bursting of the sub-soil hard pan, improving the drainage and aerating the soil.
- Reduces the bulk density of soil (0.20 to 0.4 Mg / m3)
- Two fold increase in hydraulic conductivity of sub-soil
- Conserves around 30 to 40% more soil moisture
- Roots proliferation is improved by 40 to 45%
- Nutrient mobility especially N and K increased by 20 to 30% and 30 to 40% respectively.
- Enhances the crop yield by 15 to 20%
- Residual effect can be realized for three seasons

Bullock drawn seed planter

The unit consists of a simple frame on which a seed box, hitch brackets, handle, clutch mechanism and furrow closure are mounted. The entire unit is mounted on two wheels. The furrow opener is similar to country plough in which adjustable / replaceable share is provided. The provision of cup feed type seed metering mechanism facilitates metering of seeds without breakage. The power to operate the seed metering mechanism is taken from the ground wheel through clutch. The provision of clutch facilitates stopping the seed dropping at head lands. A square bar provided at the rear covers the seed which can be easily lifted by means of rope when clods or trash are accumulated.

The seed to seed distance in a row can be adjusted by suitably changing the sprockets, thereby the required population per unit area for different crops can be maintained. By changing the size of the cup different crops/varieties of seed can be sown with this unit. The implement can be hitched to a pair of animals easily as in the case of country plough. The cost of the unit is Rs. 3500. It is useful for line sowing of crops like groundnut, sorghum, maize, cowpea, Bengal gram, green gram and black gram. The capacity of the unit is 1 ha / day. The seed planter is suitable for rainfed areas where sowing is to be completed with in a short period.

Power tiller operated cup feed seed planter

Power tiller being an ideal power source for a small farmer, a seeder attachment to it will improve the timeliness of sowing operation, especially in rainfed tracts. Moreover it will help improving the versatility and utilization of the power tiller. The attachment has all its parts integrally mounted on an easily detachable articulated double wheeled frame. It allows a shorter turning radius of 1.10 m, requiring a very small head land. The trailed frame carries the seed hopper and the metering mechanism is driven by a chain and sprocket from the tail wheel. A manually operated lever arrangement, lockable by a cable mechanism lifts the tool bar that has four hoe type furrow openers.

The spacing between seed rows and the depth of sowing are easily adjustable. The lifting of tool bar disengages the clutch transmitting power to the seed metering shaft and stops the seed metering. Row markers are provided to align the sowing rows in each pass. A separate seating attachment is provided for the operator to ride on the power tiller attachment itself. The salient features of the unit are :

- Suited for sowing Groundnut, Maize, Bengal gram, Pulses and Sorghum
- Spacing between the rows can be adjusted from 25 cm (4 rows) to 60 cm (2 rows)
- Suited for all makes of 10 to 12 hp power tiller
- Covers 1.6 hectare/day

Tractor drawn seed planter

It is a tractor drawn equipment used for line sowing of crops like groundnut, sorghum, maize and pulses. Tractor industry in India has grown and now about two lakh tractors are being produced per annum. Even small and medium farmers are hiring the tractor for different agricultural operations. Any farmer who is owning a tractor is invariably having the tractor drawn cultivator. Seed boxes along with cup feed type seed metering mechanism are mounted on the cultivator frame and the seeds are dropped in furrows opened by the cultivator shovels. Detachable side wings are fixed to the existing shovel type furrow openers of the cultivator which helps in placing the seed at the required depth. Power to operate the seed metering discs is taken from the ground wheel drive though a clutch. A square bar is provided at the back of the unit to close the furrows. The salient features of the unit are:

- Suitable for sowing groundnut, sorghum, Bengal gram, maize, soybean and pulses.
- Results in 48 and 91% saving in cost and time respectively
- Spacing can be adjusted according to the crop
- An area of 4 ha can be covered per day.

Basinlister / broad bed former cum seeder attachment to cultivator

The basin lister consists of three trenchers of width 30 cm, cams, cam shaft, cam follower, ground wheels and frame. The penetrating portion of the trencher bottoms are provided with a replaceable share point. Each trencher fitted with a cam follower gets lifted up by the cams at equal intervals. The cams are mounted on a common axle at 120 degree difference and supported by ground wheels. The power to rotate the cam is transmitted from one of the ground wheel. To reduce wheel slippage, spring tension has been provided.

The basin lister unit is attached to the standard nine tyned cultivators . The seed box along with cup feed type seed metering mechanism is mounted on the cultivator frame and the seeds are dropped in between the basins. Seeds are sown in 4 rows at 45 cm apart. Power to operate the seed metering discs is taken from the ground wheel through a clutch. The seed to seed distance can be changed by changing the sprockets provided in the metering shaft. The operator can stop the dropping of the seeds by disengaging the clutch provided. The same implement can be used to form broad beds separated by furrows by removing the basin lister attachment from the cultivator. The unit consists of two sheet metal floats fixed on both the sides of the cultivator tynes to form the broad beds separated by furrows at intervals of 180 cm. The salient features of the unit are:

- The basins/ broad beds and furrows are formed at regular intervals while sowing of crop in dry farming and conserve adequate soil moisture for the utilization of crop at its critical stages.
- Increased moisture retention of 10 per cent is achieved

Tractor operated air-assisted seeder for small seeds

In rain-fed tracts, timely sowing is crucial. Whenever there is sparse rainfall, the sowing operation should quickly take advantage of the available soil moisture before its depletion. High speed drilling is a viable option for such a situation. The developed air assisted drill consists of a seed hopper, feed regulator, air blower, and seed feeding mechanism and seed delivery system. The salient features of the unit include: the field capacity of the air assisted drill is 5.2 ha per day at an operating speed of 4 kmph; the cost of operation of the unit is Rs.160 / ha, compared to Rs.400 for the traditional method of sowing.

Conclusion

The present situation of migration of labour and thrust for more production to feed the increasing population makes dryland cultivation a necessity. In the dynamic and fast changing agricultural scenario of the country, particularly diversification in the cropping pattern and commercialization of agriculture more efficient and simple implements are required by the farmers. The potential of dry farming lands can be increased in the near future by adopting a suitable package of practices aimed at optimizing utilization of available moisture through improved soil and water management by utilizing the improved designs of moisture conservation implements.

References

Anonymous, 1987. Annual Report. All India Coordinated Research Project on Farm Implements and Machinery, Coimbatore Centre, Tamil Nadu Agricultural University.

Anonymous, 1988. Annual Report of All India Coordinated Research Project on Farm Implements and Machinery, Coimbatore Centre, Tamil Nadu Agricultural University.

Channappa, T.C. 1994. In-situ moisture conservation in arid and semi arid tropics. *Indian Journal of Soil Conservation,* 22(1-2) : 26 - 41.

Durairaj, C.D., K.Kathirvel., R.Karunanithi., and K.R.Swaminathan. 1992. Development of a basin lister actuated by tractor's hydraulic system. Agricultural Mechanization in Asia, Africa and Latin America, 23(3): 25 - 27.

CHAPTER 14

Relevance of Mechanical Sowing of Fingermillet and Groundnut in Alfisols for Dryland Agriculture

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Abstract

Finger millet and groundnut crops were mechanically sown in Marasandra and Palavalli village in Karnataka. Both the crops were sown by mechanical drill/planter and compared with local method of sowing behind country plough. The results indicated that the labour requirement of planter was 0.75 man-day/ha while 3.75 man-day /ha required by conventional method of fingermillet sowing. It resulted in 80 and 61 per cent labour and time saving respectively. Similarly sowing of groundnut using improved CRIDA planter cum fertilizer drill was resulted in 80 and 71 per cent of labour and time respectively. This also helps in better utilization of moisture for establishment at early stages of crop.

Introduction

Fingermillet and groundnut are important crops of south and central dry zones of Karnataka. It is grown on an area of 2.2 m-ha of fingermillet and 67.5 m-ha of groundnut. Both the crops can gave normal yields under adverse conditions, but major constraints in production of these crops are establishment at initial stages due to limited time and moisture availability. Timely seeding operation is most important and crucial in rainfed agriculture to maintain optimum plant population throughout crop growth period (Mayande, 1994).

Conventional method of seeding operation using animal draft power with local seeding device is time consuming besides unavailability of skilled labour for the specific operations. Efforts were made on identification, development and evaluation of suitable multi crop planter over several years. Keeping the above concept in view performance of improved finger millet and groundnuts were evaluated at different locations.

Material and methods

The experiments were conducted at two different locations to evaluate performance of finger millet and groundnut planter in comparison with local method of sowing behind country plough.

Finger millet sowing operation (Fig.1) was taken up at Marasandra, Bangalore north taluk in red sandy soil. Two farmers were selected to sow finger millet in 5 hectares by using improved tractor drawn seed cum fertilizer drill. It consists of five furrow operners at 30 cm spacing fixed in a light woodenhead piece of 6x8x160-cm size. The seed coulters are clamped at 15 cm behind and 2 cm to the sides of fertilizer coulters. So that the seeds are dropped after the fertilizer is covered with soil. Land preparation was carried out in June using tractor. Sowing of fingermillet was carryout in kharif 2002. Some modifications were made to suit local conditions. The data on placement, uniform coverage of seed and time taken to cover one hectare area was calculated and comparison were made over conventional method (Table 1).

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Table 1: Comparative performance of tractor drawn seed-cum-fertilizer drill and conventional method of sowing for fingermillet

Particulars	Improved seed drill	Local drill
Mechanical Parameters		
Power source	35 hp Tractor	Pair of bullocks
No. of rows covered in single pass	6	5
Width of coverage (cm)	180	150
Row spacing (cm)	30	30
Depth of seed dropping (cm)	3-4	2-3
Seed coverage	Not required	required
Field capacity (ha/hr)	0.5	0.12
Fuel consumption	3.0	-
Additional man power required	1	2
Cost of operation (Rs/ha)	**180**	**210**

Groundnut sowing operation was taken up at Palavalli, Pavagada taluk of Tumkur distrct in red sandy soil. Different models of sowing equipment designed by CRIDA, Hyderabad and TNAU were evaluated at dryland agriculture project, Bangalore center. Equipment were shifted to farmers' well in advance. The crop was sown in 20 ha area covering two farmers. Soil prepared to fine tilth then sowing was taken up in kharif 2002 using CRIDA Groundnut planter (Fig.2). The performance data has been presented in Table 2.

Table 2: Comparative performance of tractor drawn CRIDA planter and conventional method of sowing for Groundnut

Particulars	Improved seed drill	Local drill
Mechanical Parameters		
Power source	35 hp Tractor	Pair of bullocks
No. of rows covered in single pass	9	4
Width of coverage (cm)	405	180
Row spacing (cm)	30	30
Depth of seed dropping (cm)	4-5	3-4
Seed coverage	Not required	required
Field capacity (ha/hr)	0.76	0.22
Fuel consumption	3.0	-
Additiona man power required	1	2
Cost of operation (Rs/ha)	**220**	**240**

Results and discussion

The seeding machines were tested in the field for fingermillet and groundnut. The results indicate that mechanical sowing of fingermillet using tractor drawn seed cum fertilizer drill helped

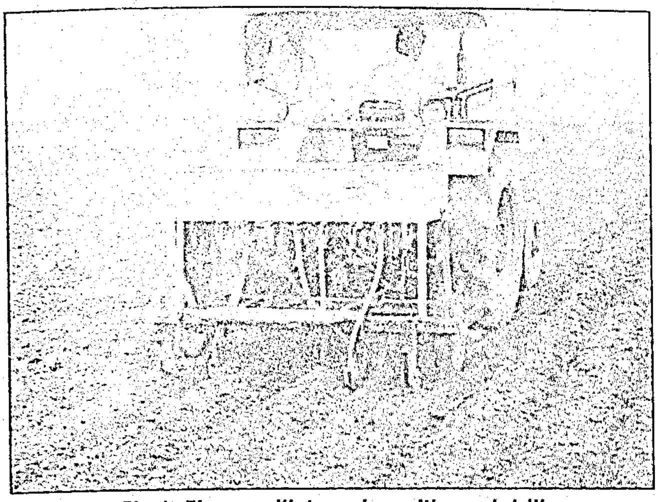

Fig.1: Finger millet sowing with seed drill

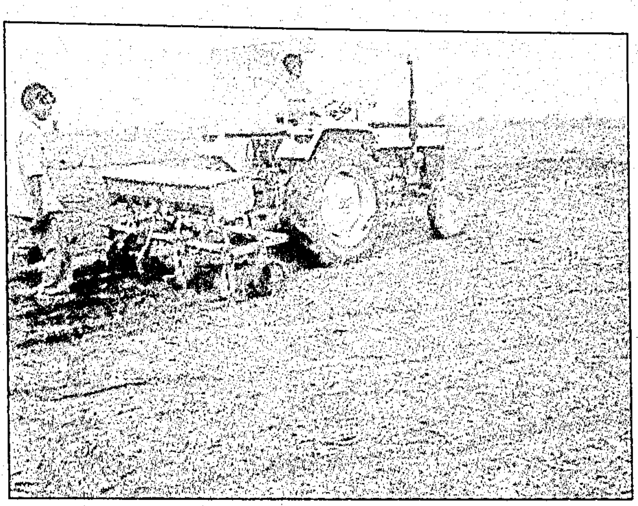

Fig.2: CRIDA - Groundnut Planter

in quick seeding with 61 per cent time saving (2hr/ha) over conventional sowing (6 hr/ha). Besides, it required 80% less manual labour (0.75 man-day/ha) as compared to conventional sowing (3.75 man-day/ha).

The groundnut planter performance also indicate that sowing groundnut using CRIDA tractor drawn planter required very low labour input (0.7 man-day /ha) as compared to conventional method (3.65 man-day /ha). This resulted in net saving of 81% labour for sowing. Time taken for sowing one ha was 1.3 hr/ha while 4.5 hr/ha in bullock drawn seed cum fertilizer drill . It indicates net time saving of 71 per cent for sowing one-hectare area. About 6.5 ha can be covered in one day by sowing with tractor drawn seed cum fertilizer drill.

Conclusion

Improved seeding implements for fingermillet and groundnut reduced labour cost and time required. Due to limited moisture availability in Rainfed areas timely sowing can be achieved through mechanization. Mechanization of finger millet and groundnut sowing in Karnataka is most feasible subject sufficient number of equipments made available locally.

Reference

Anonymous, 2001, CRIDA annual report, 2000-01.

Anonymous, 2002, Survey of Indian agriculture, The Hindu.

Mayande,V.M., 1994, Performance of seeding machines for crop establishment in rainfeds. Indian Journal of dryland agricultural research and development. 9 (1): 28-29.

CHAPTER 15

Relevance of Interculture Implements in Enhancing Productivity of Dryland Crops

V.M. Mayande[1]

Introduction

Moisture conservation is a key of success in dryland farming as crops are grown under limiting moisture conditions. Weeds compete with the crop for moisture. Hence, the cultural practices to reduce weed growth and conservation moisture should be adopted in drylands. Interculture operation aim at removal of weeds between crop rows and creating a soil mulch for moisture conservation. Improved tools like blade hoe, sweeps, rotary devices etc are commonly used for interculture operations. These tools also makes a concave soil configuration between rows so that rain water can be stored in furrow and also the ridge support the plant base. Interculturing and weeding operations are mainly human and animal powered and are often very drudgeries, costly and time consuming. Therefore, improved tools for interculture operations in drylands are essential to make best utilization of available moisture for crop growth, reduce the cost of operation, and increase yield and profitability. The issues in relevance of intercultural operation in drylands are discussed in this paper and recommendations are made for adoption and popularization of improved tools in dryland areas.

Relevance and Scope of Interculture Operations

Weeding is a very important operation in crop cultivation in drylands. If it is not done in time, the yield of the crop is reduced drastically. The average energy consumed in weeding operation for various crops is presented in Table1.

Table 1: Energy required in weeding for some important crops

Crop	Operational energy (MJ/ha)	Energy in weeding (MJ/ha)	% of operational (MJ/ha)
Paddy	19800	670	3.4
Wheat	9000	186	2.1
Cotton	6400	1409	22.0
Maize	4680	495	10.6
Sugarcane	21000	570	2.7
Potato	12000	120	1.0

***Source:** Surender Singh et.al (1999)*

Presently, weeding is practiced in four ways : i) by khurpa (a short handle tool used in squatting posture), ii) by kasola (a long handle tool used in standing posture), iii) by wheel hand hoe and iv) by chemical weeding. Experiments were conducted on energy efficiency of application of different methods in wheat crop by Surender Singh et.al. (1999). It is seen that weeding by khurpa, kasola

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and wheel hand hoe requires 105, 75 and 24 man-h/ha respectively. Weeding by wheel hand hoe can save 72, 61 and 67 percent of energy over weeding by khurpa, kasola and chemical respectively without significant effect on yield. There is also a saving of 28 to 86 per cent of operational time in weeding by kasola, wheel hand hoe and chemical as compared to khurpa (Table 2). Although presently use of wheel hand hoe is on a limited scale, farmers have shown interest in use of the implement on a large scale for row crops like maize, cotton, wheat and vegetable crops.

Table 2 : Energy required under different weed control treatments for wheat crop

Weed control method	Labour requirement (h/ha)	Energy in weeding (MJ/ha)	Saving over use of khurpa (%) Time	Energy
Khurpa	105	215	-	-
Kasola	75	154	28.6	28.4
Wheel hand hoe	24	60	77.1	72.1
Chemical	14	183	86.7	14.9

Source : Surender Singh et.al. (1999)

Interculture with mechanical devices has increased in soybean yield over chemical weed control (Table 3). This indicate that intercultural operations has added advantage of soil mulch and moisture conservation apart from weed control.

Table 3 : Effect of chemical weed control and interculture practice on Soybean grain yield

Treatment	Grain yield (kg/ha)
Twice interculture + one hand weeding	1990
Lasso liquid @ 4 litre/ha	1730
Stomp @ 3.5 litre ai/ha	1685
Basaline @ 2.5 litre ai/ha	1824

Source : *AICRPDA report (1996-99)*

Hand weeding yielded higher pod yield of groundnut and improved nutrient uptake as compared to chemical weed control (Table 4). This support the hypothesis that chemical weed control alone is not enough. Mechanical soil manipulation within crop row is must.

Table 4 : Effect of interculture operation on groundnut pod yield and nutrient uptake.

Treatment	Pod yield (kg/ha)	Nutrient uptake(kg/ha) N	P	K
Hand weeding twice at 20 & 35 DAS	1376	66.8	10.6	33.6
Metalochlor @ 1.5 kg ai/ha at 35 DAS	1243	61.2	8.7	30.1

Source : Saileja et.al. (2002)

Bullock drawn 2-row weeder was compared with khurpi and sweep hoe. Although weeding efficiency was higher in khurpi which reflected in increased grain yield of barley, the cost of operation with khurpi was highest (Table 5). Location specific factors like availability of human labour , yield advantage and benefit cost ratio etc. will determine the type of interculture tool.

Table 5 : Comparative performance of interculture tool

Tools	Weeding efficiency (%)	Field coverage (ha/hr)	Grain yield barley (kg/ha)	Cost of operation(B/ha)
Khurpi (Manual)	89	0.002	1730	920
Sweep hoe (Manual)	70	0.008	1580	480
Bullock drawn 2-Row blade hoe	65	0.050	1500	135

Source : *Singh S.R. (1997).*

Tractor drawn mechanical weeder saved 93% of human labour and 74% of operation cost compared to manual weeder (Table 6). Tractor drawn weeder moves faster and penetrates deeper for effective weed removal.

Table 6: Effect of mechanical weeder on human labour requirement and cost reduction

Weeding Tools	Human labour (man hrs/ha)	Operational cost (Rs/ha)
Manual weeder	224	421
Mechanical weeder (T.D)	16	108
Savings (%)	93	74

Source : *Guruswamy (1997)*

Triangular sweep hoe (Bullock Drawn) increased weeding index, soil moisture and grain yield with marginal increase in cost operation as compared to blade hoe (Table 7). Therefore, selection of appropriate interculture tool is also important factor.

Table 7: Effect of Interculture Tools on Weed Control and Crop Yield

Tools	Weeding Index (%)	Soil moisture at 0-15 cm(%)	Sorghumgrain yield (kg/ha)	Cost of opera -tion (Rs/ha)
Blade hoe (B.D)	73	19	920	23
Triangular Sweep hoe (B.D)	83	23	1010	28

Source : *Guruswamy (1997)*

Tillage equipment influenced the weed growth, grain and straw yield of rainfed rice (Table 8). Use of M.B.Plough showed low weed growth, higher grain and straw yield as compared to country plough. Tillage tools create a soil configuration suitable for conserving moisture and also deep tillage controls the weed growth.

Table 8 : Effect of tillage practice (tools) on weed control and grain yield of rainfed rice

Tools	Number of weeds (per m^2)	Grain yield (kg/ha)	Straw yield (Kg/ha)
Country Plough	63	3530	3760
M.B. Plough	53	3715	4020

Source : *Singh S.R. (1997).*

Interculture Tools and Equipment

1. Animal drawn weeding tool

Animal drawn cultivator with sweep attachment and animal drawn 2-row blade harrow were evaluated at Govardhanpura & Vishanpura villages in 4 ha area (at 15 farmers' fields) and 1.43 ha area (at 10 farmers' field) respectively (Table 9). The sweep cultivator has advantage over blade harrow in respect of increased field capacity, field efficiency and lower cost of operation.

Table 9 : Performance of animal drawn weeding tool at MPUAT, Udaipur

Particulars	Sweep cultivator	Blade harrow
Soil moisture content (db), %	13.70	13.50
Average field capacity, ha/h	0.15	0.10
Average field efficiency, %	73.00	60.00
Labour requirement, man-h/ha	7.00	11.00
Cost of operation, Rs/h	250.00	320.00

Source : *Research Highlights, AICRP on FIM, 2002.*

Biswas et.al. (2000) has reviewed the status of animal drawn weeders used in India. Traditional animal-drawn weeders are used widely for mechanical control of weeds. Implements with straight or triangular blades are made by blacksmiths and village artisans.

Prototype animal-drawn cultivators with shovels, sweeps or duckfoot sweeps have been introduced by several research centres. One weeder-mulcher made use of four straight blades. Wheeled tool carriers with pneumatic and steel wheels were introduced for tillage, sowing and interculture operations, but their uptake was very small. Use of rotary tools such as discs and rotating rods is limited. There has been growing emphasis on integrated weed management in farming systems.

The Central Institute of Agricultural Engineering (CIAE) recommended the use of a V-Shaped blade for the conventional bakhar or blade harrow. Studies on four basic shapes of weeding tools (straight blade, curved blade, triangular blade and sweep) were undertaken at CIAE in order to optimize tool parameters for minimum draft force in black soils. A triangular blade hoe was developed and introduced by the Agricultural Tools Research Centre, Bardoli, for secondary tillage and weeding operations.

ii. Tractor mounted cultivator for interculture

Cotton crop needs to be kept weed free for at least the first 70 days after sowing. If there is a dry spell, the interculture operations are continued even after this period for moisture conservation.

Interculture operation is carried out with bullock drawn hoes and manual sickles and the scarcity of labour always affects timely interculture in cotton crop. Dr. PDKV Akola carried out adaptive trials on tractor-mounted cultivator with different tools such as sweeps, shovels and blades for interculture operation in cotton crop in 24.21 ha area of 10 farmers' field in 10 villages of Akola district (Table 10). The comparison was made with bullock drawn blade hoe, which is a traditional practice in the region. Savings in time (80.25%) and cost (22.18%) with mechanized interculture in cotton crop was observed.

Table 10 : Performance results of tractor mounted cultivator for interculture of Dr. PDKV, Akola

Particulars	Tractor mounted cultivator	Bullock drawn blade hoe
Working depth (mm)	86	60
Plant damage (%)	10.96	14.73
Field capacity (ha/h)	0.50	0.10
Weeding efficiency (%)	71.90	62.70
Cost of operation (Rs/ha)	398	500

iii. Self propelled power weeder

The self-propelled vertical conveyor reaper windrower of one-meter size has become very popular among the farmers for harvesting rice, wheat, soybean and other similar crops. Due to the need of a high capacity weeder and also to increase the annual use of the prime mover of the vertical conveyor reaper, a power weeder was developed at TNAU, Coimbatore centre. Weeding attachments were fixed blade with sweeps hoe and rotary blades. The three designs of weeder are recommended for wide spaced crops such as cotton, tapioca, sugarcane, grapes, coconut, areca nut, other orchard and plantation crops. The hoe and sweep type weeders have three staggered tines with provision for adjusting row-to-row spacing. A gauge wheel is provided at the rear of the machine to control the depth of operation.

iv. Combination Weeder

Interculture in Soybean requires considerable amount of labour input. Effective weed control at appropriate time results in better productivity and more income to farmers. Traditional bullock drawn equipments are labour intensive and quiet straineous with low work output (Ranade et.al.2003). NRCS, Indore has developed a combination rotary weeder for soybean. It has cross bar, which restrict the swing in draw bar assembly, thereby, controlling the plant damage. This is a double action tool with front runner is sweep followed by a rotary tiller. This double action ensures uprooting, cutting and incorporating the weed mass in soil.

Conclusions

Improved tools and equipments designs are adequately available in India. Future emphasis should be on the adoption, manufacturing, promotion, training and demonstration of different intercultural tools to reduce the cost of operation, increase crop yield and profitability in drylands.

References

Anonymous, 1999. Progress report of AICRP on dryland agriculture 1996-99, CRIDA, Santoshnagar, Hyderabad - 500 059.

Anonymous, 2002. Progress Report 2000-01 of AICRP on FIM, CIAE, Bhopal.

Biswas, H.S., Rajput, D.S., and Devnani, R.S. 2000. Animal drawn weeders for weed control in India. A paper published in a resource book of the animal trection network for Eastern & Southern Africa, Technical centre for Agriculture and rural cooperation, Wagerigen, The Netherlands. pp. 134-140.

Guruswamy, T. 1997. Development and testing of bullock drawn interculture sweep hoe. Final report of Indo-US project on dryland mechanization, college of agriculture Engineering, Raichur.

Mishra, B.K. 2003. Soil tillage requirement for Rainfed Rice Production System. NATP/RRPS-16 subproject report, OUAT, Bhubaneshwar..

Ranade, D.H., Chaurasia, M.C., Sharma, R.A., and Mayande, V.M. 2003. Adoption of Improved tools for Soybean based Cropping System in Malwa Region. Research bulletin No. JNKVV/DRS/2002/11, AICRP on Dryland Agriculture, College of Agriculture, Indore (M.P) - 452 001.

Saileja, K., Bucha Reddy, B., and Devender Reddy, M. 2002. Effect of seedbed preparation and weed control practices on growth and yield of groundnut at the kharif rice. Indian Journal of Dryland Agriculture. Research & Development, 2002, 17 (2), 152-157.

Singh, S.R. 1997. Final technical report of Varanasi centre of USIF project on dryland mechanization. Department of Farm Engineering, BHU, Varanasi.

Singh, Surendra., Dipankar, De., and Pannu, C.J.S. 1999. Energy conservation technology for farm operation in Punjab. Technical bulletin No. CIAE/99/73, AICRP on Energy requirement in Agriculture Sector, CIAE, Bhopal.

CHAPTER 16

Cost Effectiveness of Manually Operated Intercultural Equipments

J. N. Khan, N. C. Shah, and Sachin Dingre[1]

Abstract

In order to ease the operation of interculture in the hilly regions of Jammu & Kashmir state, where land holding are small and rainfall / snowfall is the major source of irrigation. A number of weeding equipments were fabricated at Jammu& Kashmir centre based on the Anthropometric survey conducted at the selected sites in the state. The weeders were fabricated with a view to reduce the drudgery involved in the use of traditional tools. The use of developed tools showed an increase in yield by 5 – 8%, saving in labour by 65 – 80% and cost by 70-80% respectively as compared to conventional methods of weeding.

Introduction

Mechanization in agriculture is interjection of machinery between man and material inputs like soil, water, seed, organics, chemical fertilizers, pesticides, crop produce and by-products. Agriculture mechanization thus manifests into use of improved tools, (Pandey M. M et al 1997) implements and machines operated by human, animal and electro-mechanical power sources. Farm mechanization in India is adopted as integrating the use of available human labour and animal power with mechanical power derived from conventional as well as non-conventional energy sources (Dwarakinath, R. 2001). As subsidiary benefits mechanization simultaneously generates greater employment opportunities besides improving quality of rural life. Manually operated interculture tools are most relevant to Jammu & Kashmir state due to hilly terrain and also with ergonomic considerations to minimize the drudgery in operation.

Methodology

The selection of weed control method is influenced by the type and age of crop, the type and size of the weeds, timeliness, the equipments available and other factors (Nag and Dutt, 1979). To achieve the objective of good weed control a number of manually operated low cost weeders were fabricated at the centre. The brief specifications of fabricated hoes are given in Table1. The row crop cultivation helps us to promote plant growth by eradicating weeds. All the weeders have been designed (Gite, 1992) taking into account the anthropometric survey conducted at the selected sites of both male and female agricultural workers (Gite et.al., 1993).

Results and Discussion

The intercultural operations were performed by fabricated hoes for maize, mustard, peas and wheat crop respectively during the Kharif and Rabi season of 2002 -03. A comparison was made between the fabricated hoes and traditional methods of performing weeding operations on 330 m^2 area by all tools in wheat crop sown at 40 cm spacing (Table 2).

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Table 1: Specifications of Wheel Hoes

Sl. No.	Parameter	Single type Wheel Hoe	Rotary Hoe	Long handle Wheel Hoe	Improved hand hoe
1.	Length (cm)	106.6	134.6	203.2	114.3
2.	Width (cm)	58.4	45.72	48.2	24.1
3.	Height (cm)	104.1	63.5	96.52	—
4.	Weight (Kg)	8.5	5	11.5	1.5
5.	Power source	Manual	Manual	Manual	Manual
6.	Diameter of ground wheel (cm)	60.9	16.5	30.48	—
7.	Height of Handle from Ground (cm)	104.14	127	124	81.28
8.	Length of beam (cm)	96.5	114.3	139.7	88.9
9.	Material used	M.S Flat M.S Pipes	M.S. Pipe	M.S Flat M.S Pipes	Wood, cast iron
10.	Width of ground wheel (cm)	31.75	15.24	10.16	—
11.	Approximate cost (Rs)	280	180	350	150
12.	Suitability to crops	Wheat,Peas, Maize.	Paddy	Wheat,Peas, Mustard, Maize	Wheat, Peas, Mustard, Maize

Table 2: Field performance of different types of hoes for wheat crop

SL No.	Particulars	Single Tyne Wheel Hoe	Rotary Hoe	PAU Wheel Hand Hoe	Long Handle Wheel Hoes	Tangru Traditional	Improved Hand Hoe
1.	Working speed (km/hr)	4	2.5	2-3	2	-	3-5
2.	Effective width of cut (cm)	4	14	13.5	12	-	2.5
3.	No. of runs required in crop row	3	3	2	3	-	3
4.	Depth of cut (cm)	5	3	2	5	6	4
5.	Field capacity (ha/hr)	0.054	0.040	0.043	0.032	0.015	0.055
6.	Field efficeincy (%)	78	78	75	70	-	80
7.	Avg. No. of weeds before weeding/m²	130	145	150	135	140	145
8.	Avg. No. of weeds after weeding/m²	26	55	42	35	21	41
9.	Weeding efficiency (%)	80	62	72	74	85	72
10.	Labour requirement (persons hr/ha)	18.5	25.25	23.1	31.3	68.9	18.18
11	Saving of labour in comparision to traditional method (%)	73	63	66	54	-	73
12.	Increase in yield in comparision to traditional method (%)	7.5	6.5	6.5	6.5	-	6
13.	Saving in cost operation in comparision to traditional method (%)	72	75	77	72	-	77

The hoe were tested at selected sites of hilly region of Jammu and Kashmir. All the wheel hoes tested were suitable and gave weeding efficiency of 62-80 % and an field capacity of 0.03-0.05 ha/ hr. Increase in yield by 6-7.5% was observed. The saving in labour and cost of operation in comparison to traditional method was 54-73% and 72-77% respectively.

Conclusion

Manual wheel hoes in hilly terrain of Jammu and Kashmir found most suitable for interculture operation in wheat crop which increased yield, saved labour and cost of operation.

References

Dwarakinath, R. 2001 Technologies for sustainable agriculture published in Cartman Banglore, special issue.

Gite, L.P. 1992 Optimum handle height for animal drawn blade harrow J. Human Erogology 22, 21-27.

Gite, L.P., Bardawaj, K.C., and Bohra, C.P. 1993. Ergonomic evalution of wheeled type manual weeder. Paper presented in the XXVIII, ISAE convention of CIAE, Bhopal on March 2-4.

Nag, P.K., and Dutt, P. 1979. Effectiveness of some simple agricultural weeders with reference to physiological responses. Journal of Human Ergology, 8, 13-21.

Pandey, M.M., Majumdhar, K.L., and Singh, Gyanendra. 1997 Farm Machinery Digest, AICRP on FIM, CIAE, Bhopal.

CHAPTER 17

Design and Development of Manually Operated Cono-Weeder

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Abstract

Weed control is a major intercultural operation and always encountered as a different problem in Indian agriculture it generally involves high labour requirement, costly operation which is also painstaking due to non consideration of human comfort. The cono–weeder was designed and fabricated at college of Agril. Engg. J.N.K.V.V. Jabalpur for soybean crop. The experiment was conducted to determine weeding efficiency, field capacity and field efficiency of cono-weeder with performance comparison of wheel hoe and Khurpi. It was found that weeding efficiency and field efficiency of cono-weeder was 77% and 76% respectively, which is more than wheel hoe and Khurpi. The total cost of Cono-weeder was much less than wheel hoe. The study revealed that ease of operation, cost and operational time can be reduced by using cono - weeder.

Introduction

Weed control is one of the most important task to increase the crop yield. Weeds compete with the crop plants for the soil nutrients, moisture, light and space. Unless weeds are removed at the early stages of the crop growth, the crop yield may reduce drastically. Lack of suitable technology for weeding had been a major problem.

Generally the weeds are controlled by mechanical, Chemical, biological and crop rotation methods. In Indian conditions farmers mostly adopts mechanical weeding, which undoubtedly accomplishes the job effectively but it is costly and painstaking. Moreover due to high labour requirement many farmers do not weed their field. In biological method of weed control, certain living organism, insects or pests which destroy the weeds are utilized as a source of weed control. However the scope of wide and controlled use of this system in Indian agriculture is quit low. The crop rotation method consists of selection of proper crops in the rotation system for effective weed control, whereas chemical weeding is effective but it has got its own limitations and some time beyond the reach of small farmer because of high cost of chemicals and unavailability of spraying equipment.

The conical shaped weeder especially for soybean crop was developed. The working principle consists of tilting soils, uprooting and burying weeds through differential displacement action of blades mounted on a rotating conical shaped roller or " Cono-weeder ".

The cone provided with blades in helical arrangements used to cut weed. The design of cono-weeder based on the principal that different points along the longitudinal surface moves different linear distances when the cone is rolled along a straight path. The longitudinal mounted blades penetrating in the soil creates a variable soil displacement along its length. The portion of the

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blade on larger end or bigger diameter of cone moves the soil in a slightly backward direction against machine travel, whereas the portion of the blades on the smaller end or smaller diameter of the cone pushes the soil in a forward direction. This differential horizontal soil displacement along the length of blades enables the weeding effect in top soil layers.

Methodology

Design of cono–weeder

The methodology deals with consideration for design development of main components of manually operated cono-weeder. The cono-weeder was designed and fabricated at College of Agricultural Engineering J. N. K. V. V. Jabalpur (M. P.). It was designed mainly for soybean crop with the functional and ergonomics point of view. The width of cone was taken 20 cm as per recommended row to row crop spacing of soybean crop (Fig.1). The Uffelman theory (1961) and Bernstein equation was used for calculating bigger & smaller diameter of cone in clay soil.

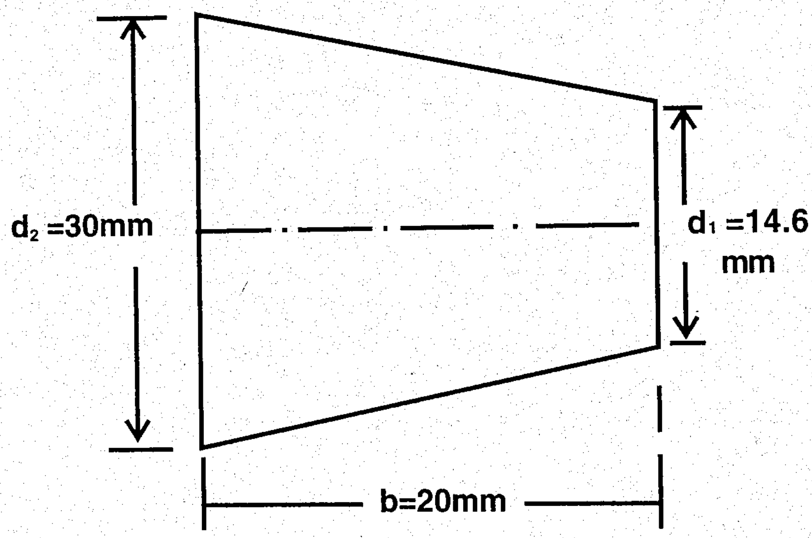

Fig.1: Diagram on optimum diameter combination

$$R=\frac{\rho^2 g^2 \pi^2 b}{507 \times 64}\left[d_2^3 + d_2^2 d_1 + d_2 d_1^2 + d_1^3 \right]$$

Where,

R = Rolling Resistant, (Kg)

ρ = Material Density, (Kg / m³)

g = Acceleration due to gravity, (m / sec²)

b = Width of Cone (m)

d_2 = Bigger diameter of Cone (m)

d_1 = Smaller diameter of Cone(m)

By several trials which suited to draft requirement for manually operated weeder, it was found that d_1 = 14.6 and d_2 = 30 cm with optimum rolling resistance / draft of 1.2 Kg.

The design of blade angle was determined according to average draft requirement and soil displacement of a single conical rotor in clay soil. The average soil displacement with 60^0, 45^0 and 30^0 angle conical rotor was found to be 18, 17 and 11 cm with 4.6, 4.2 and 3.63 Kg average draft respectively. With this information the 45^0 blade angle was found more appropriate for design of cono-weeder. The handle of weeder was designed according to anthropometric survey which was conducted at collage of Agriculture Research Farm, J. N. K. V. V. Jabalpur (M.P.). The ten body dimensions including arm reach, shoulder breadth, buttock knee length, foot length, grip diameter and grip strength were measured. These data were considered for 95th percentile of subject and accordingly handle length, width and diameter were selected. The overall specification of cono-weeder is given in Table 1.

Table 1: Specification of the cono-weeder.

Sl. No.	Name of the components	Dimensions of the component	Material used	Process used
1.	Cone	Bigger dia = 300 mm Smaller dia = 146 mm Width = 200 mm Angle of tapering from bigger dia to the smaller dia = 70^0 Weight = 5 Kg	Mango wood	Tappering
2.	Hexagonal Bar	Dia of hexagonal part = 30 mm Dia of circular part = 25 mm Length of shaft = 300 mm length of circular part at each side = 50 mm	M. S. rod	Tappering, cutting, drilling, force feeding
3.	Blade	Blade angle w. r. t. shaft = 45^0 Height of blade at the bigger end = 87 mm Height of blade at the smaller end = 25 mm Length of blade = 200 mm	M. S. rod	Cutting, bending and fixing of blade
4.	Handle	Dia of pipe = 13 mm Length of pipe =1200 mm	Conduit iron pipe	Cutting and bending
5.	Bush	Outer dia = 35 mm Inner dia = 25 mm Length = 25 mm	M. S. rod	Bending

Performance evaluation of Cono-Weeder

The experiment was carried out to calculate weeding efficiency, field capacity and field efficiency along with operational cost of weeding for different depth of cut and speed of weeder. The three weeding methods viz. weeding by Cono-weeder, by wheel hoe and manual weeding (khurpi) were evaluated conducting a replicated trial in the field respectively for soybean crop. The moisture content of three treatments were measured by collecting five soil sample at 7.5 cm depth. The average moisture content was 22%.

Result and Discussion

A series of tests were conducted to determined overall performance of cono-weeder in terms of weeder efficiency, field capacity and field efficiency. Three replication were taken for performance test and their average observation were analysed and presented in Table 2.

Table 2: Analysis of performance test for cono-weeder

Weeding Tools	Weeding Efficiency (%)	Field Capacity (ha/hr)	Field Efficiency (%)
Cono Weeder	78	0.0067	82
Wheel Hoe	64	0.0051	78
Hhurpi	77	0.0024	67

The results shows that weeding efficiency was maximum in case of cono weeder compared to wheel hoe and very close to Khurpi. Field covereage and field efficiency with cono weeder was highest.

Cost Estimation

The total cost of cono weeder was estimated as Rs. 156/- where as initial cost of wheel hoe is Rs 170/- . The initial cost of Khurpi is low. The operational cost of khurpi is Rs. 100/- per day, where as hoe Rs. 80/- per day and for cono weeder it was Rs. 50/- per day.

Conclusion

Cono weeder for soybean crop was cost effective weeding tool cover larger area with highest weeding efficiency.

References

Anonymous, 1986. Study of different weeder, CIAE Bhopal.

Anonymous, 1989. Design and Development of wheel hoe, CIAE Bhopal.

Biswas, H. S. 1983. Weeding tools and implements of India. Technical Bulletin No. CIAE / 78 / 3. CIAE Bhopal.

Gite, L. P., and Yadav, B. G.1985. Ergonomic consideration in the design of mechanical weeders. Indian Journal of Agricultural Engineering Vol. 2. No-4 Dec 1992.

Parikh, M. 1980. Hand tools for small and marginal farmers. Paper No 80 – 0105 presented at XVII annual convention of ISAE, 6 – 8 feb 1980 New Delhi.

Shrivastava, A. K., and Nema, A. 1989. Evaluation of different weeding methods for soybean crop. Silver Jubilee Convention of ISAE held at C.A.E. of R. A. U. Udaipur, 5 – 7 Jan 1989.

CHAPTER 18

Study of Precise Mechanization in Sowing & Interculture Operation of Cotton and Sorghum Crop in Dryland Agriculture

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Abstract

In Vidarbha region out of 52 lakh ha of cultivable land 42% land is under Cotton and Sorghum. Various patterns of sowing are used for these crops. Some of them are not suitable for mechanization of these crops. To select the appropriate pattern of sowing of these crops experiments are undertaken on the farmer's field. For maintaining recommended row spacing and plant population, appropriate sowing patterns were selected by keeping the standard wheel track and changed wheel track of the tractor. Mechanization of sowing of Sorghum by tractor drawn seed drill saved 69% and 50% time and cost respectively. Similarly Mechanized interculture in Sorghum saved 62% of time. By mechanizing the sowing of Cotton crop for AK-5 & AK-7 variety the saving in time was 61% and 64%, and that to saving in operational cost was 24% and 34% respectively. Similarly mechanized interculture in Cotton crop saved 85% in time, and 16% in cost of operation.

Introduction

Mechanization of cotton and sorghum is essential for timely completion of field operations for better utilization of costly inputs. Availability of farm Power is critical. Increase in Farm Power availability has helped in increasing cropping intensity and crop productivity. Thus, the dependence on mechanical Power has consequently increased.

Mechanization will help the farmers of the region to increase production and productivity of cotton and sorghum. It will lead to a solution for labour scarcity and time consumption, reducing the drudgery involved in animal drawn conventional implements. Experiments were conducted to study the suitable method of operation for mechanization of sowing and interculture of Cotton and Sorghum crop to suggest sowing pattern of cotton and Sorghum crop for mechanization of sowing and interculturing operations.

General perceptions of mechanisation

Traditional practices continue to be followed by farmers of Vidharbha region due to some misconception about mechanization. Most prominent reasons are lack of knowledge, poor financial conditions, small size of holdings etc. Farmers also feel that the available machines for sowing and interculture donot suit to their requirement. This is entirely due to lack of knowledge and exposure.

Review of literature

Kepner et al (1978): Through complete evaluation and testing of seed drill or planter could be done in the field, the results are influenced by seed viability and environmental factors which are

1. *Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola*

beyond the control of planting or drilling unit. Evaluation of seed covering device and furrow openers can only be detennined by field test but performance of a seed metering device could only be tested in laboratory. The resulting seed pattern on a grease board could be rough indication of it, since it neglects bouncing effects of seeds. Also photosensitive device and electronic unit had also been used to record paths or frequencies of falling seeds.

Bansal, R.K and Shrivastava K.L.(1981): Animal drawn implements have a continuing role to play for farming in many semi-arid, tropical countries in the foreseeable future. It is important to develop better implements to improve the efficiency and quality of farm work.

Sail J.K., Sheikh G.S., Afzal M (1981): In order to reduce number of plowing, wide-sweep type shovels were developed and attached to standards of the cultivators. Sweep cultivator was tested for adoption in country. Further the effectiveness of sweep cultivator in improving soil crop parameters were compared with the narrow type cultivator and disc harrow. However higher initial costs of disc harrow, unavailability of spare disc etc. are the constraints which discourage popularity of disc harrow among the country farmers. Sweep cultivator was considered a-better choice for seed bed preparation.

Aziz Ozmerzi (1986): The seed distribution in the vertical and horizontal planes affects the growth of plants directly- Furrow row openers on the drill machines have an important effect on seed distribution. In this research the seed distribution of four different type of coulters were investigated. Single, double disc, hoe and shoe coulters were randomly selected for this research. The effect of forward speed, working depth and chain cover to the seed distribution were investigated. With the results obtained trom the experiment, the working conditions of the coulters were determined.

Methodology

The experiments were conducted on the farmer's field. One hectare of field each for two varieties of Cotton and one variety of Sorghum has been selected for sowing the recommended seed.

a) Sowing pattern adopted for sowing Sorghum crop

Setting three furrow openers of seed drill in between the wheels of the tractor without changing the track width i.e. 60/40/40/60 cm. i.e. by adjusting three rows within the inner distance of the tyres of two wheels and after turning 60 cm row spacing was kept for allowing the free movement of the rear wheel of the tractor.

Sowing of Sorghum crop was done by tractor mounted flutted roller seed drill by keeping three furrow openers at spacing 40 cm. in between the rear tyre and drilled Sorghum seed of variety CSH -9 at the rate of 10 kg/ha. Three interculture operations were given with sweep cultivator after 14, 20, and 28 days of sowing. The data pertaining to the sowing and interculture and yield were recorded.

b) Sowing pattern adopted for sowing of Cotton (Straight Varieties)

The Sowing of AK-5 was done with the help of CRIDA inclined plate planter with 9.5 kg/ha seed rate at 70 cm row spacing and 15 cm plant spacing. Three interculture operations were given with the help of tractor drawn sweep cultivator.

Similarly sowing of AK-7 Cotton was sown on one ha. Land with the help of CRIDA inclined plate planter at 60/60 cm. by attaching three furrow openers in between the rear wheel of the tractor. The interculture operations were undertaken by means of straight blade hoe using a pair of bullock.

Results and Discussion

Sowing of Sorghum crop

Sorghum (SH.G) was sown at 40 cm spacing three rows and 60 cm spacing was left after every three rows. This tractor allowed wheels movement in wide space dur to which interculture with tractor could be done without any damage to crop. Row spacings were adjusted as per track width of the tractor. The crop establishment was very good and it gave 36% more yield than the traditional pattern. A very less damage to plant was occurred at the end of field. Because of non-changing of track width of tractor only 2 m. head land is required. Sowing operations for Sorghum saved 69% time and 62% cost of operations over bullock operated sowing. Looking at the better results and response from the farmers, a new pattern is suggested.

Table 1: Performance of mechanical sowing and interculture of Sorghum

Sl. No.	Particulars	Sowing		Interculture	
		Tractor drawn	Bullock drawn	Tractor drawn	Bullock drawn
1	Equipment used	Flutted Roller seed cum ferti drill	Tifan	Rigid type cultivator with sweeps	Straight blade wooden hoe
2	Row spacing (cm)	60/40/40/60/	45	60/40/40/60/	30 (straight blade)
3	No. of rows in one pass	3	3	4	3
4	Effective width of operation (cm)	140	135	200	135
5	Av. speed of operation, (km/hr.)	7.7	2.5	5.0	2.4
6	Field capacity, (ha/hr.)	1.07	0.33	1.00	0.38
7	A verage plant spacing	11.70	9.80	-	-
8	Plant population (lakh/ha)	1.79	2.10	-	-
9	Yield (q/ha)	27.5	17.5	-	-
10	Labour required	1 Driver	2 pairs of bullock + 2 Skilled labours + 4 Unskilled labours	1 Driver	1 pair of bullock + 3 labours
12	Cost of operation, (Rs/ha)	150	300	145	135
13	Saving in a) Time, (%) b) Cost of planting(%)	 69% 50%	 - -	62% --- ---	- 7% -
14	Increase in yield	36%	-		

I. Interculture operation in sorghum

The interculture operation was carried out by 30 cm full sweeps mounted on rigid fallow land cultivator. In which time saving was 62 % and cost of operation was little higher i.e. 7% as compared to bullock drawn interculturing. Performance results are presented in Table 1.

New pattern for sorghum crop is shown in Fig. 1. In this sowing pattern the 1.5 times width of sowing and interculture operation will be increased, which may results in increasing field capacity without any turning losses at the end of field by increasing the width of implement, the required head land will not be increase as track width will be same.

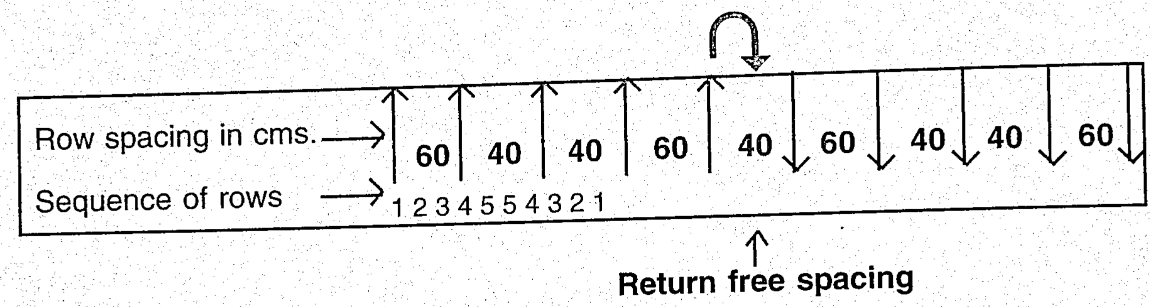


Fig.1: Sowing pattern of sorghum

Sowing of cotton AK-5 & AK-7

The farmers follow manual dibbling method of sowing for cotton crop. It was found that the field capacity of dibbling method is approximately 0.025 ha!hr and that for bullock drawn seed drill the field capacity is 0.045 ha/hr. The farmers said that the drilling method requires larger quantity of seed and hence they follow dibbling method ignoring the lower field capacity. The farmers in the surveyed area were not using tractor drawn seed drill for sowing of cotton. This clearly shows that the farmers are still stuck to traditional, time and labour consuming method of sowing because of non availability of proper sowing equipment for cotton crop.

In the trial plot of Cotton AK- 7 was sown at a row spacing of 60 cm. by attaching four rows on frame of inclined plate planter of CRIDA design. Similarly Cotton AK-5 was sown at a row spacing of 70cm. by attaching three rows on frame of inclined plate planter (CRIDA). Incase of 70cm. spacing the out of three rows outside two rows were behind rear wheel of the tractor i.e. on compacted surface of the soil. Due to the situation at the time of sowing there was low germination at these compacted rows.

Three interculture operations were given in the 70cm. row spacing only, as the free space for rear wheel was available. In the 60 cm. row spacing the interculture operation could not be undertaken by means of tractor and hence it was done by means of bullock pair.

The plant to plant spacing in both varieties was expected to place the seed at spacing of 15 cm. by using 7 cell seed plate gave deviation 9.3% and missing hills 10%. Performance results are presented in Table 2.

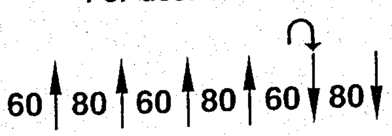
In case of Cotton sowing the mechanized sowing by Tractor saved 62% time & 27% cost & increased yield by 18% to 22%.

Table 2 : Performance of sowing and interculture mechanization for Cotton AK-5 & AK- 7

Sl. No.	Particulars	Sowing of Cotton			Interculture	
		AK-5 variety	**AK-7 variety**	**Bullock drawn local seed drill**	**Tractor drawn**	**Bullock drawn**
1	Equipment used	Tractor drawn CRIDA planter	Tractor drawn CRIDA planter	Tifan	Rigid type fallow land cultivator with 40 cm sweeps	Bullock drawn 40 cm hoe.
2	Row spacing (cm)	70	60	60	70	60
3	No. of rows in one pass	3	4	2	3	1
4	Effective width of operation (em)	210	240	120	210	60
5	A v. speed of operation, (km/hr.) including turning loss	5	4.8	3.44	4.8	2.75
6	Field capacity, (ha/hr.)	1.05	1.15	0.41	1.008	0.15
7	Time required (hr/ha)	0.95	0.87	2.44	0.99	6.66
8	Average plant spacing	16	17	13	-	-
9	Plant population (lakh/ha)	0.88	0.97	1.27	-	-
10	Yield (q/ha)	14.40	13.75	11.25	-	
11	Labour required	1 Driver	I Driver	2 pairs of bullock + 2 Skilled labours + 3 Unskilled labours	1 Driver	1 pair of bullock + 1 labour
12	Cost of operation, (Rs/ha)	150	130	198	140	167
13	Saving obtained in					
	a)Time, (%)	61%	64%	-	85%	-
	b)Cost of operation(%)	24%	34%	-	16%	-
14	Increase in yield	22%	18%	-	-	-

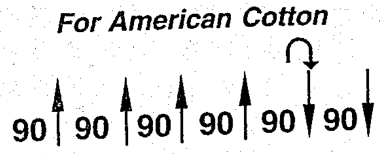
New proposed pattern for sowing of Cotton crop is as given below :

For desi Cotton



with four rows

For American Cotton



with four rows

Conclusion

Mechanization of sowing of Sorghum crop by tractor drawn seed drill saved 69% time and 50% operation cost. Similarly Mechanized interculture in Sorghum saved 62% in time only. The 36% yield was increased due to timeliness, preciseness in sowing and interculture operation. By mechanizing the sowing of Cotton crop for AK-5 & AK-7 variety saved 62% time & 28% operating cost. Similarly Mechanized interculture in Cotton crop saved 85% in time, and 16% in cost of operation. The 22% yield was increased due to timeliness, preciseness in sowing and interculture operation for AK-5 variety of Cotton crop, In AK-7 variety the yield increased by 18%. New Proposed Sowing Pattern for Cotton and Sorghum may save time, reduce, cost of operation and increase yield.

References

Aziz, Ozmerzi. 1986. Seed Distribution Performance of the Furrow Openers Used on Drill Machines. AMA, Vol. 17 (2) : 32-34.

Bansal, R.K., and Shrivastava, K.L. 1981. Improved Animal Drawn Implements for Farming in the Semi Arid Tropics. AMA, Vol. 12 : 33-35.

Bhende, S.M.1982. Design Development of Bullock Drawn Cotton Planter. Unpublished M.Tech. Thesis. Dr.P.D.K.V, Akola.

Heyns, A.J.1989. Techniques for the Evaluation of Precision Planters. Agril. Engg. Abstract, Vol.25.

Kepner, K.A., Barger, E.L., and Bainer, R.1985. Principles of Farm Machinery, The A VI Pub. Co. New York.

Sail, J.K., Sheikh, G.S., and Afzal, M. 1981. Development and Comparative Performance of a Cultivator with Sweep Shovels, AMA, Vol. 12: 39-41.

CHAPTER 19

Mechanization of Interculture, Harvesting and Threshing Operations in Dry Farming

V.M. Duraisamy, R.Manian and K.Kathirvel [1]

Crop intensification, timeliness in farm operations and efficient use of production resources will be critical inputs in increasing the productivity of agricultural sector in dry farming. A decrease in the availability of agricultural labour is a direct consequence of migration of agricultural labours to the industrial sector due to the development of market economy and rural industries. One third of the cost of cultivation is spent on weeding alone when carried out with manual labour. The arduous operation of weeding is usually performed manually with the use of traditional hand tools in upright bending posture, inducing back pain for majority of the labours. Both mechanical and chemical weeding are effective for controlling weeds. Mechanical weed control kills the weed between the rows of crop and also keeps the soil surface loose.

Harvesting of any crop is the most labour consuming filed operation. The crop is harvested by sickles. This results in peak labour demand during short period of harvest. Fast and efficient method of harvesting is the immediate need of farmers. At such stage, when timeless of harvesting operation is the main criteria, the use of mechanical harvesting of crop should be most appropriate. If the harvest is late, its yield is seriously reduced due to various losses. Efficient and timely harvesting is important to reduce the grain losses. Due to rapid urbanization and migration of farm labour to cities, a huge gap has been created in the supply and demand of farm labour. This scarcity of labour has forced the farmers to go in for mechanization. A concerted effort towards human resource development for efficient use, operation, repair and maintenance are also needed. Mechanization means to achieve field capacities that assure timeliness in seed bed preparation and to bring precision in metering seed, fertilizer, pesticides, irrigation, weeding harvesting and threshing which helps in increasing productivity with reduced unit cost of production and reduced drudgery to men and women who work in crop cultivation

Dry land weeder

This is a long handled tool and consists of 1200 mm long conduit pipe with 25mm dia over which 520 mm long handle is fitted. To the bottom of the vertical pipe frame, two arms made of 250 x 25 x 3 mm of m.s. plates are fitted. At the extreme end of the arm 120 mm dia star wheel is fixed. The cutting blade is fitted to the bottom portion of the arm and 200 mm to the back of the star wheel. The star wheel facilitates easy movement of the tool. The cutting blade cuts the weeds. The operating width of the blade is 120 mm and the coverage is 0.05 ha/day.

Sweep

It is an intercultural implement for removing shallow rooted weeds in between rows. The sweep consists of 'V' shaped shovels with bevel edged wings. The shovels are held by the tynes fixed to a frame by means of counter sunk bolts and nuts. When the sweep is used for secondary tillage, five or six tynes may be clamped with the shovels in line having no gap in between them. By just

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skimming under the soil at a shallow depth of 2 to 3 cm, the sweep breaks the capillary in the soil pores and provides a soil mulch. When the sweep is used for intercultural operations, the space between the shovels is adjusted to suit the row spacing of the crop and with different sizes of blades. The salient features of the unit are:

- Suitable for all row crops and soils
- Provides soil mulch and conserves soil moisture
- Suitable for inter cultural operations
- Coverage is 1.75 to 2.5 ha/day.

Engine operated weeder

The weeder is operated by a 3 hp petrol start kerosene run engine. The engine power is transmitted to ground wheels through V belt-pulley and sprocket - chain mechanism. At the back of the machine a replaceable sweep blade is fixed (Fig.1). Sweep blades of different width can be fitted to the machine depending on the row to row spacing of the crop. A tail wheel is provided at the rear to maintain the operating depth. The sweep blade can be raised or lowered so as to have the desired operating depth. The salient features of the unit are:

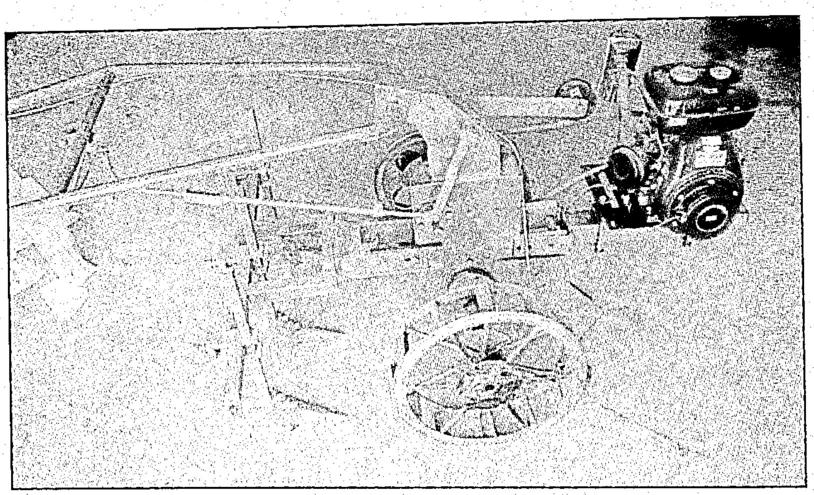

Fig.1: Engine powered weeder

- Useful for weeding between rows of crops whose rows spacing is more than 45 cm
- Can also be used for weeding and intercultural operations in orchards, coconut and areca nut plantations
- The capacity is 0.75 ha per day.

Groundnut harvester

This machine is used for harvesting groundnut crop from the field. The groundnut harvester consists of a soil loosening tool, a pick up conveying mechanism and gatherer windrower. The soil engaging tool is made of 15 mm thick x 100 mm wide x 1800 mm length straight mild steel blade. The tool at 15^0 rake angle is fixed to a main frame through shanks at both the ends. The pick up conveying mechanism of length 1700 mm is made of two 6 mm endless ship chains spaced at

1800 mm apart. Both the chains are inter connected by conduct pipes spaced at 90 mm. Straight pegs of 100 mm long with end projection are fastened to these pipes at 75 mm spacing in a staggered manner. At the rear a gatherer windrow convey the crop. It is operated by a 35 hp tractor. It weighs 300 kg with an overall dimension of 2050 x 2100 x 1150 mm. The salient features of the unit are:

- Suitable for harvesting and windrowing groundnut crop (specifically for bunch / semi spreading varieties)
- Coverage is 2 ha per day
- Harvesting and soil separation efficiency is 99 and 95 per cent
- Saving in labour cost and time is 32 and 96 per cent respectively

Fodder sorghum harvester

It is used for cutting and windrowing the fodder sorghum and similar tall crops. The machine consists of gear box, ground wheels, handle, cutter bar assembly, star wheels. conveyor assembly and gathering header assembly. Since the harvested crop is discharged at the right side of the reaper the harvester should be turned always to the left side. It is powered by 5 hp diesel engine. It weighs 75 kgs with and overall dimension of 2600 x 1200 x 1300 mm. The salient features of the unit are:

- Suitable for cutting and windrowing fodder sorghum and similar crops like maize, gingelly and palmrosa
- Coverage is 1.5 ha per day
- Saving in labour cost and time is 45 and 85 per cent respectively

Groundnut thresher

This machine is used for threshing freshly harvested groundnut crop. The thresher is of axial flow type and consists of feed hopper, spike-tooth cylinder, concave, oscillating sieves and blower. The pegs are arranged in 10 rows on the cylinder. The cylinder is enclosed with the concave made of wire mesh with sieve opening of 80 x 25 mm size. Below this cylinder concave assembly, two oscillating sieves are fitted to separate the pods from leaves, soil and other dust materials. The blower fitted in between the two sieves helps to blow out the leaves. It is operated by a 5 hp electric motor or by the PTO of the tactor. The overall dimensions of the machine is 1850 x 1600 x 1725 mm and weighs 350 kg. The salient features of the unit are:

- Suitable for threshing freshly harvested groundnut crop having high moisture
- Capacity is 200 kg pods per hr
- Threshing and cleaning efficiency is 98 and 90 per cent respectively.
- Saving in labour cost and time is 60 and 80 per cent respectively.

Castor Sheller

The unit consists of a trapezoidal shaped feeding hopper tapering towards the bottom with a shutter to regulate the feed rate. Below the shutter a screw auger is provided , which passes the castor pods to the shelling portion. The shelling portion consists of two wooden discs fastened with 6 mm rubber sheet over the rubbing faces. One disc is mounted on the shaft and the other is rigidly fixed to the frame.

The clearance between the discs can be adjusted to accommodate the different sizes of castor by sliding the rotating disc on the shaft. To clean the shelled kernels a blower is fitted. The unit may either be operated manually or by 0.5 hp motor. The cylindrical drum is rotated at 210 rpm and the blower speed is 2050 rpm. The salient features of the unit are:

Shelling capacity	:	160 kg of pods/hr
Shelling and cleaning efficiency	:	97 and 91 per cent respectively
Breakage of kernels	:	0.7 per cent
Saving in labour and cost	:	85 and 60 per cent respectively

Conclusion

Unfavourable crop growth environment, limited choice of crops and varieties, poor soils, lower cropping intensities, short growing seasons and low unstable productivity are the major concerns of dry land farmers. Agricultural labour input is becoming increasingly costlier on one side and the labour efficiency, the turnover of work and duration of working hours are deplorably deteriorating, resulting in poor crop management, increasing cost of cultivation and poor income to the farmers. Hence, farm mechanization is the need of the hour. Mechanization is not in itself the key to better yields of crop, as is often thought or implied in development projects. Farm mechanization along with increased application of other agricultural inputs such as seeds, fertilizers, pesticides, insecticides etc. has enhanced the productivity and production on farms. It also needs energy, suitable tools and implements along with operators for carrying out different agricultural operations. It also helps in conserving produce and by-products, create agro-processing industries adding value and generating additional income and employment. The principal advantages of mechanized agriculture are that it reduces the demand for labour and allows operations to be carried out faster.

References

Anonymous, 1987. Annual Report. All India Coordinated Research Project on Farm Implements and Machinery, Coimbatore Centre, Tamil Nadu Agricultural University.

Anonymous, 1988. Annual Report of All India Coordinated Research Project on Farm Implements and Machinery, Coimbatore Centre, Tamil Nadu Agricultural University.

Singh, Gyanendra.1997. Constraints to mechanisation. The Hindu, Survey ofAgriculture; pp. 173-179.

Venugopal, K., Natarajan, K., and Chidambaram, P. 1997. Farm Mechanisation - Relevanceand scope to Indian Cotton. National Seminar on Engineering Techniques for enhanced and efficient cotton production. CICR, Nagpur. 27-29th November, 1997.

CHAPTER 20

Farm Mechanization for Rainfed Haryana

D. S. Jatasra, M. S. Sidhpuria and Ashwani Kumar[1]

Abstract

Mechanization helps in covering large areas in less time especially in rainfed areas before depletion of soil moisture, thus reducing the labour requirement for increased productivity per unit area. The success of crop production in rainfed areas depends mostly on monsoon rains and any fluctuation or variations in the climate is bound to affect the crop yield. Therefore, use of suitable farm machinery is of great importance.

With the advent of green revolution in the late 60s, the Dryland Agriculture Project realized the urgent need of farm mechanization particularly in the rainfed Haryana. Before the inception of this project on the dryland farming, there were hardly any farm implement suitable for various field operations except local plough. After starting of this project, concerted efforts in this direction led to the development/ modification of implements. Behl and Kataria (1993) empasised the role of improved implements for mechanization in dryland areas.

Traditionally in these areas, seeding of kharif crops especially the small seeded ones like pearlmillet is done in shallow furrows by conventional drill or country plough. Seeding by these

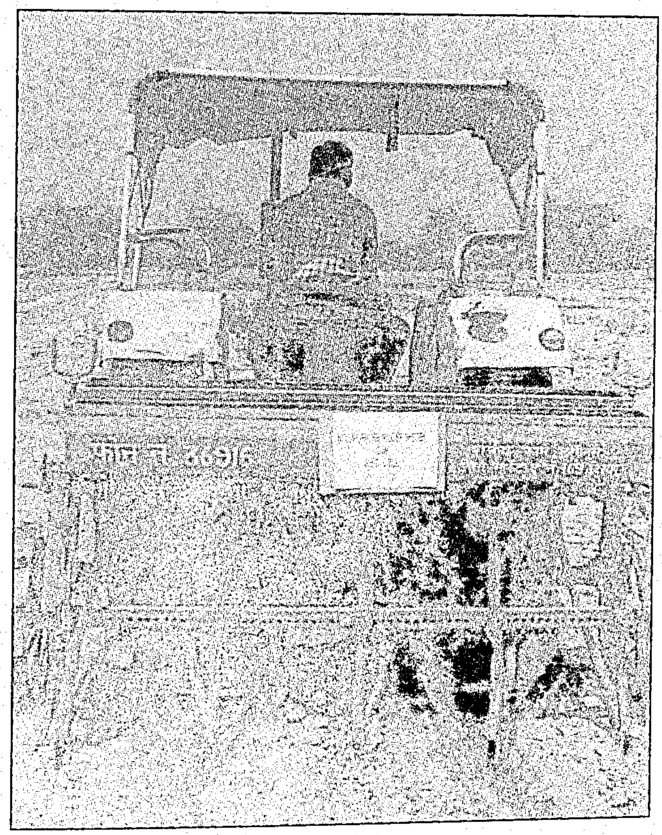

Fig.1: Ridger seeder

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practices, pearlmillet crop stand suffers due to failure of seedling emergence on account of crust formation in the event of light showers immediately after seeding. The seeding of pearlmillet crop in the 'ridge furrow system' on the shoulders of the ridges, helps in improving the germination in comparison of flat sowing. The pearlmillet seeding in ridge furrow system with tractor-drawn ridger seeder results in higher grain yield because of the fact that it constructs comparatively more stable and compact ridges and places the seeds at proper depth uniformly with little soil cover over the seeds.

The Rabi crops of mustard and gram are seeded on the moisture conserved from monsoon rainfall and under receding moisture condition due to non-availability of desired moisture within the seeding zone (0-12 cm). The seeding of these crops with traditional seeding devices becomes a serious problem.

To make more productive use of the soil moisture under these situations, the seeding of Rabi crops especially the small seeded crops like mustard is to be seeded (paired row of 30 and 60 cm) with the soil cover of 2-3 cm over the seed in the comparatively deeper moist zone constructing ridge furrow system with the ridger seeder. Mayande (1995) described the importance of suitable improved farm implements to complete various field operations within time. The use of ridger seeder (Fig.1) had resulted in significant increase in yields of pearlmillet and mustard crops as shown in Table 1.

Table 1: Grain yield of pearlmillet and mustard as influenced by seeding with ridger seeder

Crop	Soil moisture at at seeding (%)	Rainfall during crop growth period (mm)	Grain yield (kg/ha)	
			Ridge furrow seeding with ridger seeder	Flat seeding with local plough
Pearl millet	23	413	1950	1590
Mustard	16	55	1500	1100

Source: Malik, R.K. 1998

Ridger seeder increased yield by 19% in pearl millet and 27% in mustard compared to flat seeding.

Kharif crops are heavily infested with weeds. These unwanted plants compete with the crop for valuable nutrients, sunlight and available moisture. In the dryland agriculture, eradication of weeds is even more important due to scarcity of moisture. Timeliness and rapidity of weeding operation plays a vital role as use of different tools may or may not show difference in yield as long as they are effective in removing the weeds. Inter-culturing helps both ways in controlling weeds as well as restricting soil moisture loss by evaporation and through a shallow soil mulch.

For making more productive use of rainwater by reducing the evaporation losses from the cropped area, the removal of weeds and creation of soil mulch with manually operated wheel hand hoe is effective. In the region, the weeding is presently done with the help of manually operated weeding tools such as Wheel blade hoe(flat and V shaped) and kasola which are time as well as labour consuming.

The wheel hand hoe was tested and found labour saving (Table 2) with 0.50 - 0.75 acre/ person/day coverage depending upon the soil type, soil moisture and degree of weed infestation etc. Improved weeding implements can save time and energy in interculture operations.

Table 2. : Working efficiency of interculture implement (Malik, 1993)

Weeding Implement	Area covered (ha/day/person)	Weeding efficiency (%)	Yield(kg/ha)
Traditional Kasola	0.093	89	1383
Wheel Hand Hoe (Triphali Type)	0.223	75	1308
Wheel Hand Hoe (Blade Type)	0.225	82	1558

References

Behl,V. P., and Kataria, D. P. 1993. Role of improved farm implements in dryland agriculture. In Recent Advances in Dryland Agriculture, ed. L. L. Somani. Scientific Publishers, Jodhpur. pp 229 - 236.

Malik, R. K.1993. Management of rainwater for dryland farming. In Important Aspect of On - Farm Water Management, Eds. D. P. Singh and H. C. Sharma. Directorate of Research, CCS Haryana Agricultural University, Hisar. pp 41- 59.

Mayande, V. M. 1995. Improved agricultural implements for drylands. In Sustainable Development of Dryland Agriculture in India, ed. by R. P. Singh. Scientific Publishers, Jodhpur. pp 229 - 240.

CHAPTER 21

Performance Evaluation of Tractor Drawn Multi - Row Rotary Weeder

S. Rajasekar, V.M. Duraisamy, B. Shridar, and S.A. Ramjani[1]

Abstract

A tractor mounted multirow rotary weeder was designed, developed and field-tested under different moisture, depth of operation and forward speed in two types of soils. Maximum weeding efficiency at 100 mm depth of operation at 1.0 kmph forward speed and 15% moisture was observed in clay loam soil, whereas in sandy loam soil it was 83% at 15% moisture content at 85 mm depth of operation. The cost of weeding with the prototype weeder was Rs.725/ha.The savings in cost and time were 73 and 8 percent respectively as compared to conventional method of weeding. Weeding efficiency decreased with increase in forward speed at all level of moisture content and depth of operation.

Introduction

Weeding is an important operation in cotton cultivation which has to be carried out during the initial stages. In the past, there were no mechanical weeders and farmer had to use his hand to pull them out if there is conducive soil moisture. Hand weeding requires heavy labor, more time and cost during the peak season resulting in high cost of production.

The tractor drawn harrows, cultivators and blade weeders which are heavy and complicated in structure are not at all suitable for weeding operations especially in rain fed cotton. At present in India, tractor drawn rotary weeder is not developed for intercultural operation in wide row spacing crops like cotton, maize etc. Hence to reduce the labour requirement and timeliness operation, a tractor drawn multi-row rotary weeder was developed.

Methodology

Design Details

A multirow rotary weeder for cotton was fabricated with the size of 2700 x 860 x 840 mm consisting of four L shape blades mounted on the periphery of each flange with necessary supports and two sets of flange with blades were mounted on the 42 mm diameter M.S. solid shaft rotating at 217 rpm. The shaft is driven by a chain and sprockets having 1.2:1 reduction ratio through 2: 1 bevel gear transmission from tractor PTO shaft.

Field evaluation

The weeder was field tested under different moisture, depth of operation and forward speed in two types of soils in terms of weeding efficiency and cost economies in rain fed cotton crop. The performance was evaluated by the test code procedure described by RNAM

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Result and Discussion

The field performance and cost economics of the mutli-row rotary weeder was evaluated and results are presented in comparison with conventional method of weeding.

In clay loam soil the maximum weeding efficiency of 85% was obtained at 1.0 kph forward speed, 15% soil moisture and at 100 mm depth of operation. It was observed that when the depth of operation is increased from 75 to 100 mm, there is a significant change in weeding efficiency. It could be noted that the weeding efficiency decreased with increased in forward speed at all levels of moisture content and depth of operations.

The regression equation for weeding efficiency in clay loam soil:

$$Y = 142.8 - 34.7\,(X_1) - 1(X_2) - 1.9\,(X_3)$$

where,

Y = weeding efficiency, %

X_1 = speed of operation, kmph

X_2 = soil moisture, %

X_3=- depth of operation, cm

The equation indicated that the weeding efficiency has negative correlation with speed of operation, soil moisture and depth of operation, which meant that increase in speed, depth of operation and soil moisture decreases the weeding efficiency.

Cost of operation

The cost of weeding with multi-row rotary weeder was found to be Rs. 725/ha. The advantage in saving in cost and time were 73% and 81% respectively as compared to conventional method of manual weeding. The break-even point (BEP) for the weeder has been found out as 24.04 ha per annum. The machine can be custom hired profitably by any self-employed entrepreneur at Rs. 272/h.

Conclusion

The multi row rotary weeder will over come the labor requirement problem, enhance timelines operation and also reduce human drudgery. The weeder would also helps is minimize the reduction in yield and thus bring more profit to the dry land farmers

Reference

Baryeh, Edward. A. 1998. Supplemental Mechanical weed control for Maize-Cowpea Rotation in Mucuna Mulch. Agric. Mech. in Asia, Africa and Latin America, 19(1), 48-54.

Gurswamy, T. 1985. Field performance of the intercultural operation implements under dry land cultivation. Agricultural Engineering Today, 9(2); 26-34.

Rangasamy, K. et al., 1993. Evaluation of Power weeder performance, Agric. Mech. in Asia, Africa and Latin America, 24 (4), 16-22.

CHAPTER 22

Evaluation of Weeding Devices for Upland Rice

C.R.Subudhi[1]

Abstract

A replicated experiment was conducted at dry land research farm, Phulbani for 3 years. Out of five weeders tested Phulbani dryland weeder shown the highest cost benefit ratio(1.86) as well as reduced the man power in weeding operation to a considerable extent per unit cropped area.Other advantages of this weeder are that it works as the best crust breaker, a potato and groundnut digger and it can be used as a very good garden tool.

Introduction

The area of Phulbani consists of hill ranges which belong to main line of Eastern Ghats along with some plains and Valleys lying between the hill ranges. Cultivation of rice in Kharif is main crop in this zone. Weed menace is the most important among the factors pulling down the productivity of this crop. Farmers control weeds by hand picking and hoeing which become more expensive and add to the cost of cultivation substantially. Weeding by mechanical devices reduces not only the cost of labour but also time.Thus this field trial has been designed to test the efficacy of the weeders suitable for upland rice.

Materials and Methods

Eight treatments were tried with three replication in randomized block design. The experiment was conducted during 1998-2000 at Dry land research farm ,OUAT, Phulbani, with objective to compare the field perfomance and economics of operation of weeders.The treatments are

T_1-Weeding by rake weeder,

T_2-Weeding by wheel finger weeder,

T_3-Weeding by rotary peg weeder,

T_4-Weeding by Gadi(local weeder),

T_5-Hand weeding,

T_6-Weedy check,

T_7-Pre emergence herbicide with butachlor,

T_8-Weeding by Phulbani Dry land weeder.

Size of the plots were 6mx5 m.Paddy variety Zhu 11-26 was tried with a seed rate of 75 kg/ha.The fertilizer applied was 60-30-30 NPK per ha. FYM applied was 5 t/ha. Soil drainage condition was good. The pH of the soil was 5.5.The organic carbon percent was 0.2,available P_2O_5 was 9.2 kg ha^{-1} and available K_2O was 210 kg ha^{-1}.Weeder test was made after 21 days sowing of the rice.

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Table 1: Characteristics features of the weeders

Name of weeders	Width (cm)	Cost (Rs)	No of blades / pegs	Arrangement of pegs
Rake weeder	8	46	4	Zigzag
Wheel finger weeder	15	428	5	Zigzag
Rotary peg weeder	17	398	1 blade	-
Gadi(local weeder	2	30	1	-
Phulbani dry land weeder	5	15	4	Straight line

Table 2: Field performance of weeding devices

Treatments	Weight of dry weeds at harvest, tones ha^{-1}	Grain yield, q ha^{-1}	Effective field capacity,ha day^{-1}	Person-days in weeding ha^{-1}	Benefit cost ratio
T-1	0.75	29	0.076	63	1.74
T-2	0.55	29	0.091	60	1.81
T-3	0.5	31	0.079	61	1.8
T-4	0.85	30	0.019	119	1.55
T-5	1.32	26	0.016	127	1.17
T-6	8.95	2	-	-	0.23
T-7	0.62	32	-	50	1.86
T-8	0.45	34	0.071	57	1.91
SE(m)+	-	1.65	-	-	-
CD(0.05)		5.02	-	-	-

Result and Discussion

The characteristic features of the weeders tested are shown in Table 1. The arrangement of pegs is zigzag in case of rake weeder and wheel finger weeder. If for some reason, weeding operation is delayed the over growth of the weeds, block the zigzag pegs .These weeders alongwith the rotary peg weeder are not suitable when rice seeds are sown in 15 cm spacing . They cause damage to the tillers during the second weeding operation. Due to the pointed tips and longer pegs the Phulbani dryland weeder shows excellent perfomance in all type of soils with varied soil moisture levels as well as intensity of weeds.It also acts as the best crust breakers.

From the yield observations(Table-2) the Phulbani dry land weeder had registered the highest rice yield of 34 q/ha. The human labour engaged in weeding by Phulbani weeder was the least(57 per ha) saving nearly 57% labour as compared to hand weeding (127 per ha).The Phulbani dryland weeder has better weed control efficiency compared to other weeders tested. Though use of herbicide shown comparable yield, but due to its adverse effect on environment, its use may be limited to the cropped field.

Conclusion

Phulbani dry land weeder saved 57% labour compared to hand weeding. Recommended for all the crops for weeding. It can be used for crust breaking, harvesting and digging of groundnut & potato.

References

Annonymou, 2000. Annual report of Dry land research station ,Phulbani.pp(30-34)

CHAPTER 23

Harvesting and Threshing Equipments to Enhance Productivity in Dry Land Crops - Emerging Trends and Prospectives

S.J.K. Annamalai[1]

Introduction

India is a vast country with different Agro-climatic regions. About 65 per cent of the 144 million ha of the total arable land in our country depends entirely on rainfall for cultivation of crops. The dry land agriculture contributes about 44 per cent to the national food basket. It is estimated that, even after complete exploitation of the full irrigation potential of the country, nearly 70 million ha of the net sown area will continue to depend upon monsoon. It may be noted that the rainfed areas produce nearly 65 to 75 million tonnes of food grains, 12 to 14 million tonnes of oilseeds, and 10 to 12 million tonnes of pulses, accounting for 90 per cent of coarse cereals, 90 per cent of pulses and 80 per cent of oilseeds and 65 per of cent cotton. The abrassions in the weather have seriously affected, the agricultural production causing decline in area, production and productivity under various crops. The yield levels have been very low in the dry farming areas compared to irrigated areas, due to moisture stress, low level of fertilizer inputs, weed infestation and low level of energy inputs for various field operations. Though the country has been self sufficient in food grain production, the agricultural experts have expressed serious concern in the slow rate of growth. Pulses have registered a negative growth rate of 1.55 per cent during the past 10 years.

It has been projected that by 2020, India will have a population of 1400 million and per capita land availability may reduce by 50 per cent. But the food grain requirement will be 300 million tonnes. To catch up with the increasing demand, and with no additional area available for cultivation and with decline in the rainfall, the productivity per ha from the drylands will have to be increased by 2.5 times from the present level of 0.8 t/ha. Modernisation of dry farming with improved seeds, soil moisture preservation with appropriate techniques, rainwater-harvesting and mechanisation of important operations like sowing, harvesting and threshing are some of the critical interventions to improve the productivity from dry lands. Mechanisation of dry farming operation has been very sluggish and it requires a boost to revive the green revolution in dry farming.

Farm Mechanisation - Emerging Trends

Agricultural labour input is becoming increasingly costlier on the one side; and on the other, the labour efficiency, the turnover of work and duration of working hours are deplorably deteriorating resulting in poor crop management, increasing the cost of cultivation and reduced income to the farmers. Hence, farm mechanisation is the need of the hour. Mechanisation is not in itself the key to better the yields of crops as is often thought or implied in development projects. Mechanisation is to achieve timeliness and to bring precision in seeding, fertilizer, pesticides, irrigation and harvesting which helps in increasing productivity with reduced losses, reduced unit cost of production and reduced drudgery to men and women who work in crop cultivation. It also helps in

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conserving the produce and by-products, create agro-processing industries, adding value and generating additional income and employment. The principal advantages of mechanised agriculture are that it reduces the demand for labour and allows operations to be carried out faster.

Mechanisation is needed to get over some of the major constraints to enhance productivity and to make farming attractive to enable educated youth taking willingly agriculture as vocation. Traditionally, unemployment situations caused by Mechanisation get readjusted with creation of jobs in agro-processing and manufacturing industries set up in the wake of higher productivity and demand for machinery. Mechanisation also aims at increasing land labour efficiency by improving the safety and comfort of agricultural labour and to protect the environment by allowing precision operations and increasing overall income

Table 1: Farm Power available in India

Year	Tractors (per million ha)	Oil engines (per million ha)	Pumpsets/tubewells (per million ha)	Power consumption (kW/ha)
1951	0.7	5.0	1.6	1.5
1961	2.0	15.1	13.1	5.5
1971	8.6	NA	97.7	27.0
1981	30.1	162.3	250.5	4.0
1991	81.1	268.0	502.8	273.2
1992	89.0	274.7	505.5	322.6
1993	98.6	281.9	527.1	350.7

Source: *Survey of Indian Agriculture, 1996*

Table 2: Population of Farm machinery in India

Name of the machine	1951	1972	1982	1989
Tractors	8354	148200	518800	950000
Power tillers	NA	17200	NA	50000
Irrigation Pumps	115974	3240000	6876700	10500000
Plant protection equipment	NA	447900	1675500	2400000
Power thresher	NA	205800	1025000	2000000
Seed drill	NA	4073600	9040800	15000000
Iron Plough (animal drawn)	931110	5359000	6688100	7000000

Source: *Survey of Indian Agriculture, 1997*

The population of tractors and other farm machinery and equipments in our country has been in the rising trend. Mechanisation not only means tractorisation, but also making available adequate other matching equipments and implements to the farmer to reduce the human effort and improve the working efficiency. With the spread of irrigation facilities, farm mechanisation has also improved considerably in irrigated areas. The level of mechanisation can be assessed with the availability of power and population of machinery in the farms. (Tables.1& 2). The multi fold increase in tractor population and other farm equipments in the past 50 years explains by itself the increasing trend of mechanisation. However, these increasing trend is many times more in irrigated agriculture than in rainfed agriculture. The focus hereafter should be on mechanising the dry farming operations to cope up with the irrigated agriculture and by that obtain higher productivity.

Table 3: Power availability to Indian Agriculture

Source	Number (Million)	kW/unit	Total kW (Million)	kW/ha	% of Total
Male	149.20	0.06	8.95	0.05	5.74
Female	50.80	0.05	2.54	0.01	1.15
Animal	80.00	0.37	30.00	0.18	20.66
Tractor	1.71	18.65	32.49	0.19	21.81
Power tiller	0.04	5.22	0.20	0.001	0.11
Electric Motors	11.70	5.50	64.35	0.39	44.77
Diesel engines	1.50	5.50	8.25	0.05	5.74
Total	---	---	146.78	0.87	100

Source: *Survey of Indian Agriculture, 1997*

The average power availability in India is 0.54 hp/ha. It can be seen from Table.3 that the animate power contributes (manual & animal) about 41.5 million KW and the average power availability from all sources is 0.51 KW/ha. For a desirable level of agricultural productivity, the farm power required is 0.746 KW/ha. The present total energy requirement has increased additionally by 40 million kW power, which means that, the available energy has to be increased by 50 per cent. This additional requirement has to be made up by electro mechanical sources of power, coupled with measures to enhance draftability of farm animals.

The future of farm mechanisation technology package has to be eco-friendly, user friendly, facilitating the strenuous and hazardous farming operations in a safe and comfortable manner, increasing the area and productivity and facilitating custom hiring/ contract farming.

Dry Farm Mechanisation

Mechanisation of dry farming operations has become all the more relevant to ensure timeliness of operations for achieving higher productivity. It is misconceived that only farmers having large acreage could reap benefits of mechanisation. The major requirements for achieving high productivity, namely better soil preparation, timely sowing and correct placement of seeds, better water, pest and fertilizer management, reduced harvesting and threshing losses and timeliness of field operations can be all achieved only by mechanisation of theses operations. Studies have revealed that tractor powered farms have increased cropping intensity by 11 per cent and crop production by 4 times as compared to bullock powered farms. The level of mechanisation, however, is very low in dry farming crops. Unlike irrigated agriculture, rainfed farming is mixed with livestock farming. Draught animal and human power will continue to be used, but these are inadequate to ensure timeliness. Therefore improved machinery to suit agro-ecological and economic diversity will have to be introduced. Farmers have accepted the importance of farm mechanisation to increase production but the high cost of investment in the farm equipment is a major constraint and appropriate policies and methodologies would have to be developed for dry farming mechanisation.

Low purchasing power, low literacy and resistance to change from traditional system, inadequate credit facilities and poor risk bearing ability, are some of the socio economic and infrastructure constraints in dry land mechanisation.

Harvesting and Threshing Equipments for Dry Farming

Harvesting and threshing operations form a major activity in dry farming, requiring greater manpower. Traditional methods of harvesting and threshing involve high labour with low efficiency and higher field losses. The untapped yield reservoir is quite high in the dry farming systems; reduction in the cost of cultivation and reduction of the field losses through mechanisation of harvesting and threshing operations would increase the net revenue and the net yield recovered. The human drudgery to accomplish these operations is also higher forcing the agricultural labour to shy away from these jobs or to demand higher wages. The non-availability of labour during the peak season of harvest is also another factor causing delayed harvest resulting in greater field losses. The delayed harvesting also increases the turn around time and delays the taking up of the subsequent crops. While equipment and machinery for tillage and sowing dry land crops have been widely adopted by the farmers to a reasonable level, the mechanisation of harvesting and threshing operations remain still at a very low level, Some of the promising and proven harvesting and threshing equipments which can be adopted dry lands are enumerated below:

Harvesting tools and Machinery:

Improved sickle

The improved Naveen Sickle developed by CIAE, which costs about Rs 30/-, has a serrated blade. The cutting force is drastically reduced in this sickle compared to traditional sickle; It consists of serrated blade, ferrule, and wooden handle. Operator's safety has been taken care by providing appropriate size of raised wooden handle. The unit is suitable for harvesting wheat, rice, grasses and thin stalk crops. Using this improved sickle, one person can cover 0.018-ha/h and the labour requirement is 80 man – h/ha.

Animal drawn diggers

It is operated by pair of bullocks and used for digging of groundnut and potato. It can also be used for secondary tillage operation (harrowing). It consists of beam, frame, handle, ground wheel depth adjustment mechanism and V-blade. The field coverage of the animal drawn digger is 0.05 to 0.12 ha/h with the field efficiency of 60 per cent. The labour requirement is 8-20 man – h/ha. The operating cost is Rs. 220-470/ha.

Self propelled reaper

It is a 6 hp diesel engine operated walking type reaper where crop cutting and conveying mechanism are mounted on the front of the unit. It consists of handle, engine, cutter bar, crop row divider (4 nos.), star wheel, conveyor belt and lugged wheels. The machine is suitable to harvest cereals and oilseeds. Two gearboxes, one for lugged wheels and other for cutter bar are used. The field coverage of the reaper is 0.23-0.25 ha/h with the forward speed of 2.35 to 3.90 kph and the field efficiency of the machine is 65 per cent. The grain losses during the operation were observed to less than 1.0 per cent and the fuel consumption is 0.7 to 1.0 l/h. The labour requirement is 5 Man – h/ha and the operating cost is Rs. 380/ha. The price of the machine is Rs. 50,000/-. The machine with a few modifications has been developed in to a multicrop harvester for other dry land crops like Safflower, Sorghum etc.

Power tiller operated soybean reaper

It is an 8-10 hp power tiller front mounted reaper to harvest soybean, Bengal gram, green gram, black gram and similar bushy crops (Fig.1). The reaper consists of cutter bar, reel, platform, and gauge roller; hitch plate, power transmission system, dog clutch and mainframe. The machine can cover about 0.09 to 0.12 ha/h with the operating speed of 1.4 to 1.8 kph. The efficiency of the machine is about 74 per cent and the labour requirement is 2 man –h/q. The fuel consumption is only 0.6 l/h.

Fig.1: Soybean reaper

TNAU Fodder Sorghum harvester

The machine consists of gearbox, ground wheels, handle, and cutter bar assembly, star wheels, two conveyor assemblies and gathering header assembly. The machine requires 1 operator and 2 labours to collect and bundle the harvested crop. The field capacity of the harvester is 1.5 ha/day. It can save around 45 per cent of labour cost and 85 per cent time over conventional method of harvesting.

Tractor mounted vertical conveyor reaper

It is a 35 hp or above tractor front mounted reaper to harvest rice and wheat crop (Fig.2). It consists of cutter bar, conveying system, row divider (7 nos.), telescopic/universal shaft, lifting side-rods, gearbox and mounting bracket. Tractor PTO is used to drive the cutter bar and conveying system. The tractor mounted conveyor reaper can cover about 0.31 ha/h with the forward speed of 2 kph. The field efficiency of the machine is 74 per cent with only 1.5 per cent of grain losses. The labour requirement is 3 Man - h/ha.

Side mounted reaper

It is a 25 hp or above tractor rear side mounted reaper to harvest wheat, gram, soybean and other crops. It is most suitable to harvest crops of bushy nature. It consists of frame, three point hitch system, power transmission system, cutter bar, reel, crop hoard etc. Tractor PTO is used to drive cutter bar and reel through unit's drive system. The operating speed of the reaper is about 1.5 to 3.0 kph with the field capacity of 0.40 ha/h. The field efficiency of the reaper is about 66 per cent.

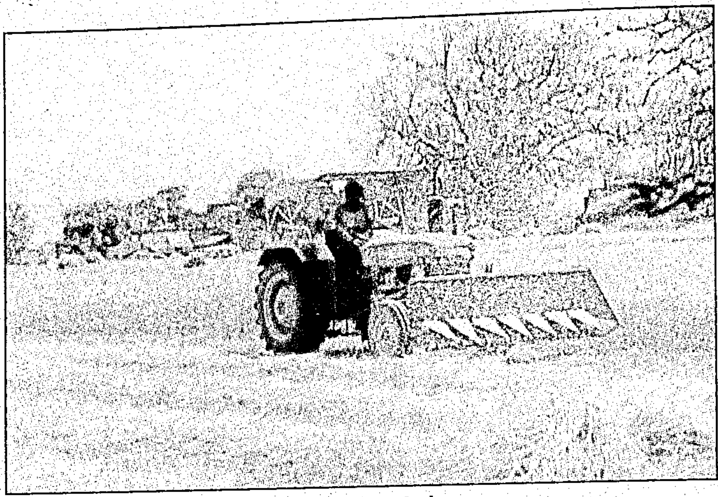

Fig.2: Tractor mounted reaper

The labour requirement is 2.5 man – ha/h and the fuel consumption is about 1.38 l/h.

TNAU Tractor operated groundnut harvester

The TNAU groundnut harvester attached to a 35 hp tractor consists of a soil-loosening tool, a pick up conveying mechanism and gatherer windrower. The harvesting efficiency and the soil separation of the machine is 99 per cent and 95 per cent respectively. The machine can save about 32 per cent labour and 96 per cent of time over conventional method of harvesting. The cost of the operation is about Rs. 600/ha.

Threshing Equipments:

CIAE Multi crop thresher

The multi crop thresher has been developed by CIAE to cater to the needs of the farmers to thresh common dry farming crops, replacing existing single crop thresher. It is suitable to thresh wheat, maize, rice, gram, pigeon pea, soybean, mustard, and safflower and linseed crop. The thresher is operated by 5 hp three phase electric motor and consists of feeding tray, spike tooth cylinder, concave, top cover, aspirator blower and sieve shaker. The cylinder speed is variable from 7 to 21 m/sec for various crops. Threshing and cleaning efficiency of the multi crop thresher are about 98.8 to 99.90 per cent and 93 to 99 per cent respectively. The capacity of the thresher is about 200 to 1635 kg/h and the labour requirement is 0.24 to 1.0 Man – h/q. The total grain losses are 0.8 to 2 per cent only. The operating cost is Rs. 18/q.

CIAE - Semi-axial flow multicrop thresher

The CIAE semi axial flow thresher handles the crops by moving them axially over a spike tooth cylinder. It is suitable to thresh crops like wheat, soybean, sorghum, maize, pigeon pea, rice, sunflower and safflower and is operated by 7.5 hp three-phase electric motor. It also has an aspirator blower, sieve shaker and transport wheels. The threshing and cleaning efficiency of the multi crop thresher is about 99.5 to 99.8 per cent and 99.3 to 99.9 percent respectively. The capacity of the thresher is about 350 to 1350 kg/h and the labour requirement is 0.3 to 1.0 Man – h/q. The total grain losses were 0.5 to 1.5 per cent. The operating cost is Rs. 13/q.

CIAE High capacity multi crop thresher

The CIAE high capacity multi crop thresher is suitable for large holdings and custom hiring. It is suitable to thresh crops like wheat, maize, Sorghum, gram, soybean, pigeon pea and sunflower. The thresher is operated by 20 hp three phase electric motor or 35 hp motor PTO. It consists of hopper with automatic feeding, spike tooth cylinder, three-aspirator blower, and concave shaker unit, bagging unit, hitch system and pneumatic transport wheel. The cylinder speed is variable from 8 to 14.6 m/sec. Threshing and cleaning efficiency of the multi crop thresher is about 98.3 to 100 per cent and 93.4 to 99.9 per cent respectively. The capacity of the thresher is about 533 to 2890 kg/h and the labour requirement is 0.2 to 0.6 Man – h/q. The total grain losses are 0.5 to 2 per cent only. The operating cost is Rs. 20/q.

TNAU Groundnut thresher

The thresher is an axial flow type and it consists of feed hopper, spike-tooth cylinder, concave, oscillating sieves and blower. The machine is suitable for freshly harvested groundnut crop of high moisture content and it can also be operated by tractor PTO. The capacity of the thresher is 200 kg pods/h. It can save around 60 per cent labour cost and 80 per cent of total time over the conventional method of threshing. The cost operation is Rs. 22/q.

Groundnut cum castor decorticator

It is a manually operated equipment to separate kernels from groundnut and castor pods. The unit consists of frame, handle, oscillating arm and separate sieve for groundnut and castor. The capacity of the decorticator 60 to 68 kg/h with the shelling efficiency of 93 to 98 per cent. The braking of kernels and the total losses are about 2.3 to 2.65 per cent during shelling. The labour requirement is only 1.6 man – h/q. The operating cost is Rs. 18/q.

Combine Harvesters

Combine harvester is a machine, which performs the functions of a reaper, thresher and winnower. The functions are: cutting the standing crops, feeding the cut crop into the threshing unit; threshing the crop; cleaning the grain, freeing it from straw and collecting the grains in a container.

ESCORTS - Self propelled combine-Crop Tiger

It is powered by a 58 hp engine. The reaping width is 2100 mm. The combine has rubber tracks for forward travel and all operations in this machine are hydraulically controlled. The separating system comprises shaking sieves and fans. The machine can work even in small slushy fields and when the straw is completely bruised. The cost of the machine is about Rs. 15,00,000. The coverage is 0.4 ha/h. the combine has already become popular and custom hired by private entrepreneurs.

SIFANG Rice & Wheat combine harvester

It is a smaller version of the combine harvester, which can work on paddy and Wheat. It cuts the panicles at the top and cuts the straw at the bottom with two sets of blades. The panicles are fed in to threshing cylinder. It is powered by a 18.5 hp engine. Some of the bigger models of combine harvesters are already available in Indian market but their rates are very high ranging from 7 to 14 lakhs and the small farmers could not dream of possessing them. This combine harvester model is available at a cost of Rs 2,00,000/-, which could enable even a small farmer to afford the machine. The combine harvester is light in weight, easy to operate and available at an affordable price.

Tractor mounted combines with pneumatic wheels

The "STANDARD" make combine harvester is mounted on a 45 hp tractor. The cost of the harvester is about Rs. 3.5 lakhs (without tractor). The width of cut is 3.68 m. The field coverage is 5 ha /day. There losses of grains in harvesting, threshing, cleaning or along with the straw, are only minimum.

Mechanisation Strategies

Three sets of foundation are necessary for mechanizing dry land farming to promote agricultural growth – Technology, Policy and Institutions. They represent the three spokes of the wheel and unless all the 3 spokes of the wheel are strong, the wheel cannot move forward with desired speed. The Technologies available for mechanizing harvesting and threshing have been discussed above. If policies and institutions are not conducive, adoption of these new technologies may render them waste. Some important aspects to formulate appropriate policy for successful mechanisation are discussed below.

Rapid mechanisation through custom hiring group and contract farming

The level of mechanisation in the country, as a whole, is still very low. The investment in the agricultural machinery vis-à-vis their utilisation on small farms is quite high. However, in the present circumstances, when labour wages are increasing and their availability at peak times of sowing, harvesting and threshing is decreasing, the farmers are now getting more inclined towards the use of agricultural machinery. Custom hiring of tractors for tillage, transport, irrigation and combine harvesting is already in vogue in many parts of the country and will be further accelerated. Mechanisation of agriculture through group farming and contract farming will ensure modernisation of agriculture and quality farm produce. Efforts must be diverted at attracting capital investment in agriculture by encouraging contract and corporate farming. With flow of private capital, introduction of mechanisation technology would be quicker. To encourage this, the ceiling on dry lands and wastelands must be revised.

Liberalisation of credit policies

The centrally sponsored scheme namely "Comprehensive modernisation of agriculture through mechanisation" is being implemented for providing financial assistance for the purchase of self propelled speciality machines with the basic objective of providing adequate financial support to the small farmers, may be extended to the dry land farmers also through group loans, custom hiring service agencies, self employment scheme for rural youths and subsidies. Banks may liberalise their credit policy for farm mechanisation in dry land.

Farm Machinery Clinics in Villages

Farm machinery clinics, if established in rural centres for promoting the custom hiring of the farm equipment by the small farmers, would provide a solution to the problem of the non-affordability of the costly machine by the dry land farmer. These clinics will also act as service centres for the machinery to carry out repairs and maintenance. The village youth may be encouraged for self-employment by starting the farm machinery clinics. These farm machinery clinics would play a critical role in generating jobs and in sustainable lively hoods in rural areas. Government and developmental agencies should come forward to promote the establishment of these clinics in a viable manner. These clinics can form a part of entrepreneurship development programmes for manufacturing, marketing and custom hiring of the machinery, which will be the vital link for achieving the mechanisation goal.

Participatory Extension services

Promotion of Agricultural Technology Management Agencies (ATMA) would help in the process of grass root level adoption of the mechanisation technology. These agencies may help in corporatisation of custom hiring services of the farm equipment. The Self Help Groups in villages also may be promoted to own and manage these farm equipments.

Alternative employment to Rural Labour

For agriculture to remain competitive despite being largely a smallholder operation, use of factors like manual labour would have to be optimized. Selective mechanisation of agriculture is one option that would merit deep consideration. Directing public effort at weaning rural people, particularly labour, from exclusive dependence on agriculture and providing them with accessible opportunities to earn dependable higher income from alternate employment would go a long way in mitigating rural poverty and promoting agricultural growth. Widening the scope of non-farm employment in rural sector by attaching the capital flow to the rural sector through different programmes would help in a big way for the adoption of mechanisation.

Training and Education

To achieve the goal of higher farm production efficiency, efforts may be made for the skill development of rural people through education and training.

Conclusions

Mechanisation of agriculture will have profound effect on the socio - economic conditions in the rural areas. It will be a powerful tool in checking the migration of rural labour. Mechanisation of harvesting and threshing equipments in the dry farming could go a long way not only in enhancing the productivity but also in improving the quality of work of the rural labour. Many technologies for mechanisation of harvesting and threshing operations have been developed and they have to be introduced appropriately in the dry farming sector together with appropriate policy and implementing institutions for successful adoption. Mechanisation technology clubbed with workable custom hiring service system would help in achieving the goal of higher productivity in dry land farms. The mechanisation strategies and policies to promote corporate and contract farming; establishment of farm machinery clinics, liberalisation of institutional credit and active involvement of extension services through self help groups in the villages would play major role in realising the targets to meet the challenges in making our country richer and prosperous through agricultural growth.

References

Anonymous, 2002. Survey of Indian Agriculture 2002. The Hindu, Chennai. Page No: 209.

Anonymous, 2002. Product catalogue 2002, Central Institute of Agricultural Engineering, Bhopal.

Manian,R., Kathirvel,K., and Balashankari. 2002. Farm Mechanisation – Emerging Trends. New Dimensions and Approches for Sustainable Agriculture. Director of Extension Education, TNAU, Coimbatore. Page No: 267-290.

Salokhe, V.M., and Ramalingam, N. 1998. Agricultural Mechanisation in South and South-East Asia. Inter National Conference of Philippines. Society of Agricultural Engineer, Las Banos.

CHAPTER 24

A Mechanical Harvester for Rainfed Safflower Crop

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Abstract

A self propelled walk behind type reaper harvester suitable for Safflower crop has been designed and developed by the Central Institute of Agricultural Engineering Regional Centre, Coimbatore under the National Agricultural Technological Project. The machine is powered by 5.4 hp diesel engine. The machine could harvest and windrow the spiny and bushy Safflower crop, covering an area of 0.159 ha/h with the field losses being 0.58 per cent. By using this machine for harvesting Safflower, there would be savings in cost by 23.14 per cent and savings in labour by 70.73 per cent. The machine can be custom hired profitably by any self-employed entrepreneur/small farmer. The mechanical harvester will help in reducing the human drudgery and the cost of cultivation and thus bring more profitability to the dry land farmers growing Safflower.

Introduction

Safflower, an oil seed crop, is grown generally as an inter crop with cereals and pulses and is traditionally grown as a rainfed crop on residual soil moisture. The crop is harvested manually with sickles in the early morning hours when there is dew on the crop to prevent shattering losses as well as injury from the plant splines to the workers. Due to the difficulty in handling of Safflower crop, the interest in this crop has been declining in the last few years among the farmers. Hence, to aid in easier harvesting of Safflower, a mechanical harvester was designed and developed at the Central Institute of Agricultural Engineering- Regional Centre, Coimbatore under National Agricultural Technology Project (NATP) during 2001-2003.

Design Details

The self propelled harvester with the overall size of 2800 x 1000 x 1350 m consists of two main parts namely, power unit with engine as a prime mover and reaper unit.

The power unit comprises of the prime mover, power transmission system with gearbox, axle and ground wheels, handle, accelerating lever and a clutch lever. The reaper unit consists of frame, cutter bar assembly, guiding and gathering assembly, and vertical conveying flat belt assembly, "V" belt and bevel gear drive system for harvester and eccentric crank and pitman assembly. The specifications of the harvester are given in Table 1.

Field Evaluation

The prototype harvester was fabricated and field-tested in farmer's fields in Bijapur, Solapur and Osmanabad districts during 2002 and 2003 (Fig.1). Long duration trials were conducted with the prototype harvester as per the RNAM test code procedure. The field trials were conducted in collaboration with NATP-MMP on dry land Mechanisation, MPKV, Solapur.

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Table 1: Technical specifications of safflower harvestor

S.No.	Particulars	Specifications
1	Type	Self propelled, vertical conveyor reaper windrower type (front mounted)
2	Prime mover	5.4 hp Greaves Lombadini diesel engine (1800 rpm)
3	Crop guiding	Header assembly with star wheel
4	Cutting	Reciprocating type cutter bar
5	Conveying	Vertical conveying to the right side
6	Windrowing	Right side discharge in the collection tray
7	Power transmission	i. Belt-pulley drive with tensioner clutch to engage and disengage drive from engine ii. Two stage chain sprocket reduction drive to ground wheel axle in a oil bath type assembly. iii. Belt pulley drive from gear box to reaper unit for cutter bar and conveyor belt through 90 deg bevel gear systems iv. Drive to cutter bar through eccentric crank assembly and drive to conveyor pulley through 3:1 sprocket chain reduction drive. v. Drive conveyor chain at the top taken from extended drive shaft of conveyor pulley.
8	Overall weight	200 kg
9	Overall dimension	2800 x 1000 x 1350 mm
10	Forward speed	2.5 kph
11	Cutting width	750 mm
12	Minimum height of cut	50 mm
13	Controls at the handle	i. Acclerator lever ii. Wheel clutches iii. Clutch lever iv. Lever to stop the engine
14	Traction	Pneumatic mini tiller wheels
15	Cutter bar	Reciprocating knife blades 10 nos. of 75 mm pitch
16	Cutting speed	1.5 m/s for safflower
17	Header assembly	2 nos., length – 800 mm
18	Crop divider	1 no.
19	Star wheels	2 nos., diameter – 180 mm, inclination – 30°
20	Conveyor belt	2 nos., width – 75 mm, speed – 0.89 m/s., lugs –10, lug size – 95 mm
21	Conveyor chain	1 no. at 1.2 m height
22	Collection tray	Size –1335 x 730 x 500 mm attachment (for safflower harvesting only)
23	Crop suitability	Safflower, sorghum (non lodged), wheat (non lodged)

Fig.1: Safflower harvester

Results and Discussion

The performance of the harvester in comparison with conventional method of harvesting of Safflower is discussed below.

Performance of the harvester

The field capacity of the prototype harvester was found to be 0.159 ha/h, while a manual labour could cover only 0.0155 ha/h for harvesting with sickle by conventional method. The filed efficiency of harvester was observed to be 84.83 per cent. The field losses for the machine were found to be 0.58 per cent.

Cost of operation

The cost of operation per hectare for harvesting Safflower inter crop with machine was found to be Rs 666.30 /ha. The advantage of savings in cost of operation was about 23.14 per cent over conventional method of harvesting Safflower, which was Rs 859.86/ha. The savings in labour requirement by machine harvesting was higher than manual harvesting by 70.73 per cent. The Break Even Point (BEP) for the harvester has been worked out as 23.8 ha per annum. The Pay Back Period will be about 3 years for the machine. The machine can be custom hired with profitability by any self-employed entrepreneur/small farmer at charges of Rs 135-165/h.

Conclusions

The Safflower harvester would be a boon to the farmers as it would help in eliminating the physical handling of the spiny crop and thus reduce the human drudgery. The harvester would also increase the profitability to the farmers by reducing the cost of operation and the labour requirement substantially.

Acknowledgements

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References

Anonymous, 2002. Annual Report 2001-2002, NATP-ROPS-5, Co-Operating Centre, Central Institute of Agricultural Engineering, Regional Centre-Coimbatore-641003.

Anonymous, 2003. Annual Report 2002-2003, NATP-ROPS-5, Co-Operating Centre, Central Institute of Agricultural Engineering, Regional Centre-Coimbatore-641003.

Anonymous, 1983. Test Code Procedure for Harvesting Machines, Part 11. RNAM, United Nations Development programme, Philippines.

CHAPTER 25

Comparative Evaluation of Vertical Conveyor Reaper for Finger Millet (*Eluesine coracana*) under Different Sowing Treatments

B.Jayanthi, N.T.Sudarshan Naidu and S. Javare Gowda

Abstract

A reaper was modified and evaluated for harvesting finger millet in dry lands at GKVK, UAS, Bangalore. It was observed that the harvester works satisfactorily for ragi under rainfed conditions to minimize cost and time of operation. The observations showed that machine has field capacity of 0.24 ha/hr, fuel consumption of 0.65 litres/hr and cuts at an average stubble height of 7.40 cm above the ground level. It was also observed that at particular moisture content of the crop stalk the cutting and windrowing of the crop was more effective. The cost of operation for harvesting was Rs. 31/hr.

Introduction

Harvesting is one of the most important operation in finger millet crop.Timely operations and greater speed of work are required to ensure quality and reduces losses. Human labour is costliest input in farm operations contributing about 60% of total cost of cultivation. The ardous operation of harvesting crop is usually performed manually with the use of traditional hand tools like sickles which consumes 25% of total labour. This situation necessitates the introduction of suitable machine for harvesting. There is a great demand for suitable harvester for crops like finger millet, green gram, redgram etc., Presently self propelled reapers and combine harvests have shown the ways for mechanical harvesting.

The farmers of dry region of Karnataka often experience uncertainity in crop yield as the rainfall in these areas is very low, unpredictable and ill distributed. Majority of the farmers of this region are unaware of the harvesting machine. A study was undertaken to evaluate the performance of vertical conveyor reaper for finger millet.

Material and methods

Operation search

A study was conducted in a village which comes under easten dry zone of Karnataka situated in dry land area of Kolar district. Major crops in kharif are ragi (finger millet) and groundnut.

Adoption of vertical conveyor paddy harvestor for finger millet

Based on the findings during operation search, a need of a small power unit with attachment of harvesting finger millet for medium and large farmers was identified. Keeping this in view a self-propelled vertical conveyor reaper of 1 metre width developed at IRRI with 5 hp diesel engine was adopted for ragi harvesting (Fig.1).

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Fig.1: Finger millet harvester

Modifications to the vertical conveyor reaper

The vertical conveyor reaper for paddy was having only one gear system for forward movement and also there is no mechanisms for smooth turning of machine at corner of the field. Because of these two problems the operator felt difficulty both in turning and to move the machine backward. The transmission system and gear box along with the handle of Krishi power tiller was fitted with original reapers 5 hp diesel engine and cutter bar assembly by fabricating some of the parts.

a. Engine base plate bracket : To mount the engine at rear side of the gear box, a 50 cm length engine base plate was fabricated and used. It has been made out of 6 mm thick and angle MS sheet.

b. Mower assembly : It has been fabricated to fix the cutter bar unit on the front side of the gear box. This frame is made out of 6 mm thick MS sheet. The engine and cutter bar unit can be mounted in such a position that entire unit is balanced, relieving the operator of any strain due to load.

c. Gear system : The gear system is adopted has 4 forward and 2 reverse speeds. This has to over come the drawback of the original harvesters gear system which has only forward speed.

d. Steering clutch levels : The gear box along with handle adopted has two steering clutch levers on either sides of the handle which facilitate easy turning at corners of the field during operation. It over comes the drawback of turning problem of machine for the operation.

e. Pneumatic wheels : Pneumatic wheels if 52 cm dia are fitted by replacing the lugged wheels for easy movement in the dry land field. The design specifications are presented in Table 1.

Results and discussion

Trials were conducted in dry land at GKVK during the kharif harvesting season to know the performance of the harvester. It was observed that the modified harvester works satisfactorily. The results are presented in Table 2.

Table 1 : Performance of power tiller operated vertical conveyor reaper for harvesting finger millet

Particulars	Test - I	Test - II
A. Crop parameters		
Crop variety	HR 379	HR 374
Age of the crop at the harvesting time (days)	110	115
Normal period of maturity (days)	110-115	110-120
Plant height (cm)	85-90	72-80
Plant population (per m^2)	181	120
Row to row spacing (cm)	30	30
Moisture content (% w.b)		
Stem	16-18	17-18.5
Grain	12-13	12-13.5
B. Operational parameters		
Average speed (km/hr)	3.5	3.55
Fuel consumption (lit/hr)	0.55	0.55
Effective cutter bar width (cm)	70	70
C. Field performance		
Effective working width (cm)	60	60
Area of operation (ha)	1.2	1.8
Stubble height (cm)	7.0	6.8
Field capacity (ha/hr)	0.25	0.37
Field losses (%)	1.00	1.20

d. Speed at different gear

Gears	Engine speed	Gear transmission rpm	Wheel axle rpm	Distance covered m/min
I	1750	445	9	14.67
II	1690	440	22	13.86
III	1740	445	38	91.94
IV	1740	450	100	163.00

Table 2 : Performance evaluation of vertical conveyor reaper during operation

Particulars	Observation
Field capacity	0.23 ha/h
Fuel consumption	0.65 litres/h
Cutting height of stalk above ground	7.2 cm
Width of operation	3 rows in 90 cm

It was observed that engine had excessive vibration which resulted in more fatigue to the operator. During the next trial the vertical reaper unit was further modified to reduce excessive vibration by addition stiffners replacement of bearings and use of better quality fasteners for cutter bar assembly.

The unit was extensively tested in two different ragi plot at UAS, GKVK, campus. The test results indicated that the modification incorporated in reaper unit can successfully reduce the vibration, provides stability to the cutter bar assembly and harvesting of ragi crop was quite satisfactory.

The crop and harvester parameters were recorded to evaluate the performance. The effective field capacity of machine varies from 0.25 to 0.30 ha/hr at operating speed of 3.5 kmph. The variation in the field capacity depend upon the speed of operation and skill of the operator. The average fuel consumption of 55 lt/hr was recorded during field testing.

Conclusion

1. The self-propelled vertical conveyor reaper could be used for harvesting ragi with normal plant population crop canopy to minimize cost and time of operation.
2. For easy moving of cutter bar and minimize cutter bar vibration the cutter bar assembly has to be mounted on a (diesel engine) power chasis
3. The over all performance of modified reaper was satisfactory for dryland ragi.

References

Devnani, R.S. 1980, Harvesting equipments developed in India Technical Bulletin, CIAE/78/4, Bhopal.

Bansal, N.K., and Singh, Bachan. 1988, Performance evaluation of animal drawn engine operated vertical conveyor reaper for paddy. ISAE paper No. FYM 188-91.

Guruswamy, T., Wesai, S.R., Veeranagowda., and Barker, 1996, Performance evaluation of vertical conveyor reaper windrower. J. Agril. Engg., 9(1) : 102-105.

CHAPTER 26

Farm Machanisation using Hi-tech Agri-implements and Plant Protection Equipments

Thomas Mathew and G.R. Chandra Mohan[1]

It is very relevant in the present situation of mechanization in agriculture to introduce some power operated hand tools which are very useful not only to ease the work but also to reduce the time consumption and the cost of labor, thereby contributing to the reduction in cost of production. It is already a common practice in developed countries, using machines for most of their farm works but in India it is in the beginning stage. It is also important cutting the cost of production because now India is competing for the world market.

M/s ANDREAS STIHL AG & Co., of Germany is the world renowned name ;11 manufacturing hand held power tools useful in agriculturel horticulturel plantation. We, JANGAN TRADING INDIA, their Indian distributors are bringing this new technology for the use of Indian farmers. Some of these equipments include Brush. (weed) cutters, Earth Augurs. Chain saw, Hedge Trimmers, Telescopic Pruners etc.

Brush Cutters

It is a shoulder hung unit consisting of a petrol engine fitted with a long shaft to which required cutting tool can be attached. The total weight of the machine varies from 5-7 kgs depending on the model and power. The cutting tool is rotated as the engine runs at a certain speed which can be controlled by a hand operated trigger, fixed on a bike handle on the shaft. By using differen_ blades the brush cutter can be operated to clear unwanted weeds, tough grass, parthenium, and medium forest stands. The machine can be used in any type of terrain. A single man can o::>erate the machine without much fatigue. On a level land and normal weeds, he can clear about 2-4 acres in a day (8 hours of operation) where the machine will consume approximately 6 liters of petrol oil mix and it clearly indicates considerable saving in labor cost and time.

Different attachments can be fitted to the brush cutter viz, Cultivator, Hedge Trimmer, Power Swaeper etc. to enable different operations.

Earth Augur

It is again a one man operating machine consisting of a petrol engine and attached is a drill of required size (from 40 mm to 260 mm diameter). As the engine is accelerated by a hand operated trigger, drill attached to it starts rotating and holding it from the place where it is required to make pits, it starts driiling. The loosened earth is removed by pulling out the drill along with the machine wl1ile it is sill at full speed. A clean pit is thus obtained.

As per UPASI evaluation, one operator with an assistant can make 1200 pits of 6 inches diameter in 5 hours of operation. The machine consumes 3.5 liters of petrol oil mix giving a cost reGl.'ction of 47% and labor saving of 66%.

Chain Saw

This is mechanized alternative for cutting trees, logs and firewood to manual sawing. Here, the cutting is very fast and the operator fatigue is very minimum. A fast running chain with cutting

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teeth on it rotates on a guide bar by means of-engine power. A safety chain brake is provided to stop the chain in a fraction of second in case of emergency. Any type of tree llogs etc. can be cut using chain saw reducing the depe"dency on labor.

Hedge Trimmer

It is an engine operated scissor, which is useful in trimming hedges from top and also from the sides. Two blades, one above the other reciprocates as the engine speeds up giving it a scissor action, cuts the hedges neatly. Required height can be maintained by holding the blades.

Telescopic Pruners

These are branch pruners very useful in orchards, coffeeltea estates and other horticulture crop3. Manual and engine operated telescopic pruners are available. The manual one is of very light weight (2.5 Kg total) and is extendable up to 18 feet Including operator's height it will give an effective height of 21 to 22 feet, thus making branch cutting easy (no need of climbing). Its removable blade is made out of wear resistant chrome steel, where re-sharpening is not required and thus making it a maintenance free equipment.

The motorized version has got an engine to do the manual effort, where a chain saw is attached to the telescopic shaft. The maximum height is 13 feet and with operator's height it will give an effective reach of 18-19 feet. The chain saw is held against the branch to be cut and the engine is accelerated, the branch will be cut within no time. By using these equipment, the work will De very fast and it includes less risk of safety.

Plant Protection equipments

LU-SHYONG machinery Industries Ltd., of Taiwan, an ISO-9002 certified company, is the manufacturer of world class plant protection equipment and we M/s Jangan Trading India, their authorized distributors are supplying the same in India which include two and three piston HTP sprayers, two piston backpack motorized sprayers, electrical motor operated sprayers, high quality, light weight spray lances, nozzles etc,.

Compared to conventionul sprayers, these are very advanced in technology and the quality of spray is very high. The spray pumps are highly durable and they can be coupled to any conventional engines/tractors/tillers or electrical motors of required power. The spray lances and nozzles are lightweight and adjustable to get fine mist or long distance jet, which makes them suitable to any types of crops. As they produce a very fine mist of spray, the chemical (pesticide/insecticide/ fungicide) is evenly distributed over the plant and underneath the leaves providing complete coverage and minimum wastage. As the spray coverage is more, time consumed in spraying is minimized. A variety of lances and nozzles are available to cater different applications. The backpack model is useful for spraying in coffee/tea estates where the difficult terrain requires special sprayers. The engine coupled to the spray pump is of % HP and is highly fuel efficient (400 011 of petrol & oil mix per hour). In the gradient landscape of the estates, the spraying speed will be less and using conventional sprayers, where there is no regulation of speed is possible, the quantity of chemicals sprayed will be too much and maximum chemical will be wasted. In Lu-Shyong backpack sprayers it is possible to stop the spraying whenever it is not required without stopping the engine, thereby saving chemicals and getting adequate spraying for the plants.

In the present scenario, because of the uncertainty in market the farmers are at the receiving end. It is always uncertain that what price he is going to get for his produces. Hence our farmers need to do some home work on their expenditure of production. The above said implements will definitely help in checking production cost as they bring down labor cost and save useful time.

CHAPTER 27

Linkage between Research Institutes Development Departments, Industries and Farmers

V .M. Mayande[1]

Dryland Agriculture constitutes about 67% of total cultivated area in India and contributes only 42% to food production. Timeliness and precision in field operations are key factors governed by available power and status of mechanization in dryland ecosystem. The resource poor farmers with small and marginal holdings dominate these areas. Human and animal resources in these areas are continuously dwindling leading to time consuming operations and unusual increase in cost of operation. Conventional tools and equipments are no longer adequate to meet the needs of precision dryland agriculture, besides timeliness being the first casualty. Power and mechanization constraints are leading conventional dryland agriculture into a non-profit and risk prone enterprise. Introduction of powered mechanization systems thus has become absolutely necessary for sustainable dryland agriculture. These emerging issues need to be addressed to provide a viable solution for mechanization of dryland agriculture.

Research institutes have developed number of useful tools and equipments suitable for various operations in dryland agriculture. However, these designs have not reached to the users due to several missing links in the chain. The consolidated efforts are needed to put in place a system in consortium mode linking research institutes, development departments, industries and farmers. So far research institutions have been working in isolation and trying to transfer improved designs through development departments. In spite of large subsidization of prices by the central and state government the useful equipment could not reach to the needy people as manufacturing quality of equipments could not be maintained by handpicked industries to meet the supply deadlines under subsidy quota.

Development departments have spent millions of rupees on subsidizing agricultural tools and equipments during last 5 decades. However the results are not in commensurate with the investment made by the government. The following points must be considered by the development departments before subsidizing the equipment.

1. Select the need-based equipment.
2. Equipments selected should meet the timeliness and precision requirement.
3. Selected industry should be given sufficient time for quality manufacturing of tools.
4. Quality control measures should be strictly adhered.
5. Concerned scientist should be involved in the process of selection of equipment and quality control checks at Industry level.

These are some of the observations, which will help development departments in successful implementation of the mechanization program under subsidy scheme.

Industry has a crucial role to play in mechanization of dryland agriculture. The industry should

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be located at each block level or at the most district level to reach farmers in their jurisdiction.

Research institutions have been shying away in associating with industry due to several reasons. However, with revival of policy guidelines now institutes can develop direct linkage with industry for transfer of design and assisting industry in quality control aspects. These efforts have already been initiated by CRIDA and MoU's has been signed with 17 industries in A.P, Maharashtra, M.P, Rajasthan, Karnataka etc. Licensing of the designs to industry and agreement for quality control measures will go a long way in maintaining institute-industry partnership for benefit of the farmers.

Farmer is a focal point for research institutions, development departments and industries. Therefore the consortium of Research Institute, Industry, Development department and Farmers must be developed at national, state, district and block levels to reap the benefits of mechanization by dryland farmers (Fig. 1). This kind of consortium will lead to revival of next green revolution through mechanization of dryland agriculture.

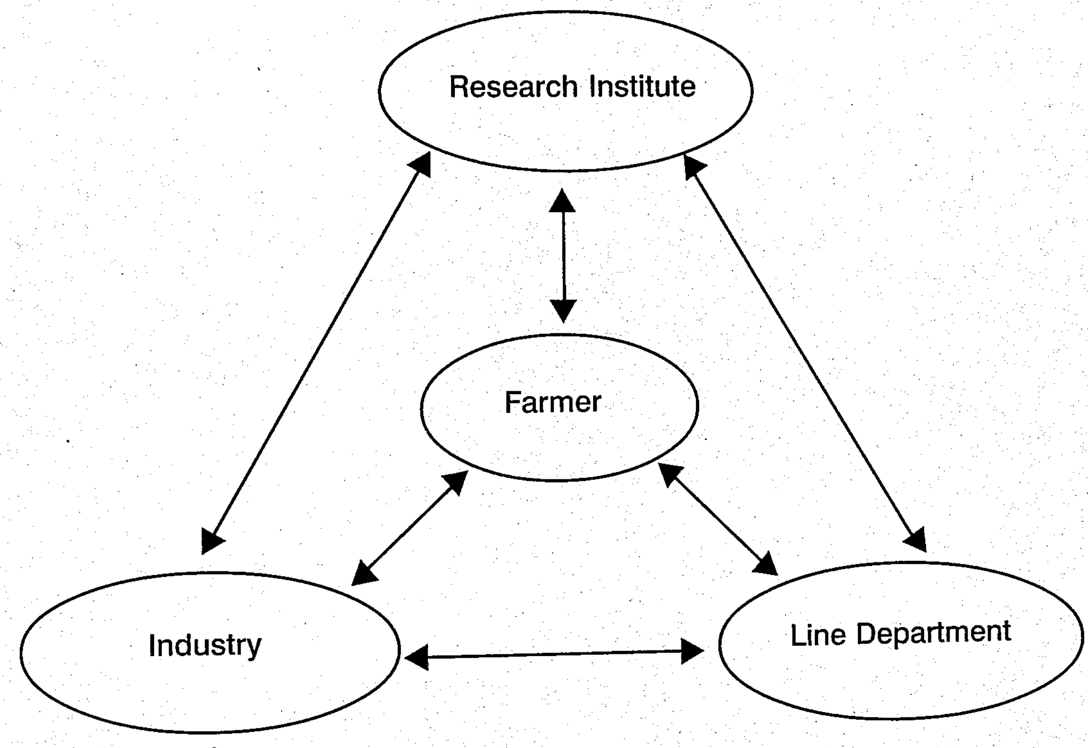

Fig 1: Institute - Industry -Line Department - Farmer Consortium

CHAPTER 28

Role of Financial Institution in Promoting Mechanization of Agriculture

H. Bharatkumar[1]

Introduction

Developing of agriculture depends on use of improved technology for cultivation to increase cropping intensity and productivity per unit of land. Mechanization of farm operations is one of the critical factors contributing for the improvement in the cropping intensity, better use of irrigation potential, adoption of multi cropping pattern, improved production and productivity per unit of land. Mechanization of farming has been considered as one of the important inputs in farming to complete the farm operations in time, efficient land operations and also to facilitate transport of farm inputs and produce. With the rapid commercialization of agriculture, there has been an increased use of farm machines like tractors, power tillers not only to tide over the problem of seasonal shortage of agricultural labour but also due to the efficiency and spread of operations of the machine.

Eligible Investments under institutional finance

i) In the traditional sense, bankers consider extending credit to tractors, power tillers, agricultural implements, crushers, combined harvesters and plant protection equipments under farm mechanization.

ii) After the concept of commercialization has started seeping in to the minds of farmers/ entrepreneurs, mechanization has spread its wings and has entered into the realms of a wide range of activities, starting from production of Agriculture in controlled conditions, primary processing involving grading/ sorting, transporting the produce, processing and packing etc. Mechanisation has also been prevalent in allied activities like dairy, poultry and fisheries sectors. These new areas are briefly Discussed in the following paragraphs.

- Green house cultivation of flowers/vegetables - High value crops meant for export and also for marketing in major cities are grown under controlled conditions so as to meet the international standards. In such cultivation, the exact microclimate required for each crop is regulated through use of machinery. After production, the produce is subjected to a series of grading/ sorting packing under controlled conditions. The stipulated conditions are maintained even when the produce is exported/ reaches the final market through the cold chains/cold storage conditions.
- Further the usage of water saving devices such as drip/sprinkler irrigation system has become quite common in traditional agriculture.
- Processing of fruits and vegetables - Machineries are used in various operations starting from grading./sorting, processing, packing and quality control.
- Cold storages and scientific storage godowns - creation of scientific storage structure are very important from the point that around 6% of the food grains and 30-40% of the horticultural

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produce produced bare wasted every year due to inadequate storage /processing. Further, inadequate storage facilities force the farmers to resort to distress selling and from the viewpoint of consumers, they have to pay heavily for the horticulture products during off seasons.

- Biotechnology- biotechnology has become a buzzword during the past few years and its applications in agriculture ranges from tissue culture to genetic modification. Various tissue culture labs producing uniform planting materials having specific quality viz., high yielding / having resistance to biotic / abiotic factors have come up in the recent years.
- Another activity taken up in completely controlled environments is production of button mushrooms. Of late., the awareness on the nutritional aspects of mushrooms is spreading among the common population and the demand is increasing.
- Coming to the agriculture allied activities, mechanized dairy and poultry units milk processing, poultry and fish hatcheries, feed manufacturing units etc. are being set up the entrepreneurs.

Role of financial institutions

The farmers/ entrepreneurs are eligible for availing term loans ranging between 75% and 95% of the total investment cost for development purposes. The cost in respect of the various activities (other than traditional investments) are worked out on a project basis considering various aspects such as availability / cost of various inputs and raw materials, managerial skill, technical know how/ man power, marketing infrastructure, technical feasibility, financial viability and bankability. Further, the short-term /working capital requirements will have to be assessed on a case to case basis depending on specific requirements.

Rates of interest

The Reserve Bank of India had deregulated the rates of interest to be charged to the ultimate borrower in respect of Commercial Banks. I.e., each bank can decide on the rate of interest to be charged to the ultimate borrower. Other financial institutions like Regional Rural Banks and Co-operative Banks etc., are at liberty to decide the lending rate for all limits based on the source and cost of their funds. However, the minimum rate of interest should not be less than 12%. Rate of interest on NABARDs refinance varies from 6.75 to 9.5% depending upon type of bank and quantum of loan.

Role of NABARD

NABARD has been popularizing the concept of mechanization in agriculture and also commercialization in various areas/ new and innovative projects since its inception in 1982. Apart from the refinance assistance, NABARD has been supporting these activities through:

- Potential estimation and credit planning - the exercise of potential; estimation of various investments are carried out by NABARD up to block level in each district.
- Estimation of costs for traditional investments- the State Level Standing Committee on Unit Costs having members from financial institutions / Government Departments and Research institutions, convened by NABARD once in a year, fixes the indicative costs for various investments.

- Technical appraisal, standardization of techno economic norms, monitoring and evaluation of the performance of the sector.
- Identification of improved/advanced bankable investment models.
- Extending R&D assistance for selected research efforts.

Taking up the issues related to infrastructure inadequacies coming in the way of organized development of this sector, with appropriate agencies.

In order to supplement the existing extension let work to accelerate the process of technology transfer to agriculture and providing supplementary sources of input supply and services, NABARD also provides assistance out of the "Soft loan Margin money Assistance Fund'. Further, we have also prepared model project/ illustrative profile in respect of a few activity areas.

- GOI has announced the Capital Investment Subsidy Scheme for Construction/ Expansion/ Modernization of Cold Storage and Storage for Horticulture Produce since 1999-2000 and the subsidy of 25% of the financial outlay subject to the capacity created, is routed through NABVARD and the monitoring of implementation of the projects are done by us. Since last year, storage godowns for grains and onion storages are also covered under the CISS.
- In order to give a boost to agricultural exports from the country, GOI has identified 28 zones and notified 15 of them for creation of Agri. Export Zones. NABARD too has identified this has a thrust area for extending necessary support for its orderly growth. Accordingly, it has been decided to provide refinance to commercial banks for financing of farmers for cultivation/Production of identified crops/ commodities in AEZs under contract farming. NABARD will also be helping the State Governments for creation of the required infrastructure in these zones out of the Rural Infrastructure Development Fund.