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A Case Study:

Fingermillet harvesting and threshing in Karnataka

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ABSTRACT

Finger millet also known as Ragi or Mandwa is the most important small millet food and fodder crop. It is extensively cultivated in Asian countries like India, Ceylon, Malaysia, China, Nepal and Japan and African countries. It is widely grown in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujarat and Maharashtra and in the hilly regions of Uttar Pradesh, Sikkim and Himachal Pradesh. Karnataka is a major finger millet producing state in India covering about 43 per cent area of finger millet cultivation and producing nearly 49 per cent of the total food grain production (Anonymous, 2010). This crop is grown both in dryland as well as in irrigated conditions where irrigation facilities are available and it constitute only 5 per cent area of the finger millet grown in Karnataka. Whereas the rain fed finger millet is about 95 per cent and usually it is grown in *Kharif* and irrigated finger millet in *Rabi* or summer. Finger millet is often intercropped with legumes if it is grown under rain fed condition. Finger millet has outstanding properties as a subsistence food crop. Its small seeds can be stored safely for many years without insect damage, which makes it a traditional component of farmers' risk avoidance strategies in drought-prone regions of Eastern Africa and South Asia. Because the seed can be stored for decades (some say 50 years), it is highly valued as a reserve against famines. Finger millet is especially valuable as it contains the amino acid methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava, plantain, polished rice, or maize meal. Finger millet can be ground and cooked into cakes, puddings or porridge. The grain is made into a fermented drink (or beer) in Nepal and in many parts of Africa. The straw from finger millet is used as animal fodder

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It is estimated that harvesting and threshing of crops consume about one third of the total requirement of the production system (Ojha and Devnani 1987)The energy analysis made in the dry track of Karnataka indicated that cultivation of irrigated finger millet required significantly higher energy than cultivation of rain fed finger millet. Seedbed preparation, weeding, irrigation and harvesting were found to be most energy intensive operations. In rain fed cultivation seedbed preparation, weeding and intercultivation, harvest and post harvest operations were found to be most energy intensive operations. Seed bed preparation in rain fed crop consumed maximum energy (40.50 %) followed by harvest and post harvest operations (24.36 %). This was due to the fact that more human power was used in these operations compared to other operations. Harvest and post harvest operations were the second most energy consuming operations for both rain fed and irrigated crops, since in traditional agriculture, more human power was used for these operations (Chowdegowda *et al*., 2010).

Timely harvest of the crop is vital to achieve better quality and higher yield. The shortage of labour during harvesting season and vagaries of the weather cause grater losses to the farmers. Finger millet is harvested either manually by using sickle if it is intercropped with legumes or by reaper windrower if it is grown as single crop. In irrigated crop the ear heads will be harvested first and then the straw after few days. After harvest it is dried in the field for 3-4 days and then stacked for at least one month in the field itself and then transported to threshing yards, which fosters a fermentation whose heat and hydrolysis makes the seeds easier to thresh. Finger millet is threshed either by beating the crop manually with stick or by treading in case of small farmers, large scale threshing is by passing bullock stone rollers or a tractor with or without stone roller over the crop spread uniformly on the threshing yard. Spreading of the finger millet crop on the tar road and waiting for transport vehicles to pass through is also a common practice followed by the farmers near the main roads for threshing finger millet. After threshing it is winnowed and cleaned. Now a day's finger millet is also threshed by multicrop threshers.

Different methods of finger millet harvesting, threshing, their efficiency, recovery percentage,

germination and economics are studied and discussed here.

Harvesting:

Harvesting of crop if one of the important agriculture operations which demands considerable amount of labour. Traditionally, finger millet is harvesting is done manually using sickles which involves 25 man days per hectare. Scarcity of labour and higher wages during harvesting season is the serious problem.

Manual harvesting:

Crop is harvested by hand, individual heads are cut off with a sickle, leaving a few centimeters of stalk attached or whole crop is harvested at base level leaving a few centimeters of stubble on the ground. 200 man hours are required to harvest one hectare of finger millet. One man can harvest 0.005 hectare per hour with an efficiency of 99 per cent. It involves drudgery since manual harvesting is done in a sitting posture. Finger millet intercropped with legumes can be harvested only by this method.

Harvesting with power tiller mounted reaper:

It is possible to harvest the finger millet if it is mono crop. There will be reduction in the yield of straw because the height of cut (stubble height) is more when compared to manual harvesting with sickle. It is due to surface roughness and vibration and also to avoid stones and other foreign material come in contact with the cutter bar (Chauhan, 1983). Power tiller mounted reaper found suitable to harvest fingermillet crop. It cuts the millet crop at a height of 13.6 cm, covers an area of 0.28 hectare per hour with field efficiency of 96 per cent. The field loss like left over crop in the field is more than manual harvesting but it will be in acceptable limits (Kumar *et al.*, 2006) (Table 1).

Harvesting with tractor mounted reaper:

The stubble height and field losses are also high as in case of power tiller mounted reaper. But the tractor mounted reaper can harvest 0.5 hectare per hour as the cutter bar length and the forward speed is more when compared to power tiller mounted reaper. This method of harvesting is suitable only if the finger millet is grown as single crop.

Threshing:

Threshing is separating grains from ear heads. After threshing, grain and husk are separated by winnowing and cleaning. The different methods of threshing finger millet are discussed here.

Threading under men feet:

It is suitable for threshing only the ear heads and small quantity under shelter even in bad weather conditions. Finger millet ear heads were threshed under men/women feet. It is very slow process and its output capacity is very low, needs cleaning after threshing and cost of threshing is high. It is a method of threshing with no damage to grain and hence there is no effect on germination of seeds.

Hand beating manually:

Threshing of dried finger millet ear heads by beating with sticks is a practice when small quantity for seed purposes. It is quite faster than threading under men feet, less grain damage and no effect on germination of seeds.

Table 1 : Comparative performance of reapers for harvesting rainfed and irrigated fingermillet

Particulars	Power tiller mounted reaper		Self propelled KAMCO make		Self propelled CIAE make		Self propelled Local make		Manual harvesting
Power source	15 HP Diesel Engine		3.5 HP Petrol start Kerosene run Engine		6 HP Diesel Engine		3.5 HP Petrol start Kerosene run Engine		Man power
Height of cut (cm)	136.00	(106.00)	102.00	(92.00)	121.00	(98.00)	102.00	(92.00)	53
Speed (km/hr)	3.23	(3.67)	2.27	(2.58)	2.04	(2.38)	2.38	(2.68)	-
Field capacity (ha/hr)	0.28	(0.28)	0.13	(0.13)	0.12	(0.12)	0.13	(0.14)	0.005
Mech- hour (hr/ha)	3.60	(3.40)	7.90	(7.85)	8.37	(8.26)	8.00	(7.85)	-
Man hour (hr/ha)	15.00	(23.00)	25.00	(24.00)	20.00	(20.00)	3.42	(10.53)	-
Fuel consumed (lit/ha)	4.32	(4.23)	7.03	(6.89)	8.37	(7.93)	7.12	(6.91)	-
Wheel slippage (%)	11.13	(10.13)	9.78	(8.93)	10.09	(9.01)	9.83	(8.67)	-
Field efficiency (%)	96.00	(98.00)	90.00	(95.00)	88.00	(90.00)	90.00	(94.00)	99
Field loss (%)	3.10	(3.50)	2.78	(2.98)	2.65	(2.92)	2.81	(3.09)	1.5

(Kumar *et al.*, 2006)

Table 2 : Summary of results of mechanical threshing of finger millet using "Almaco" plant and earhead thresher

Particulars	Cylinder speed (m/min)				
	2215	1665	1295	1095	Mean
Threshing efficiency (%)	95.79	94.42	93.08	90.53	92.31
Mechanical damage (%)	17.66	4.53	0.67	0.14	4.82
Germination (%)	66.28	73.72	77.27	79.72	71.42
Vigour index	780.5	895.22	929.09	950.94	888.94

(Narayanaswamy and Javaregowda, 1989)

Table 3 : Summary of results of mechanical threshing of finger millet using "LCT" thresher

Particulars	Moisture content (%) of *Indaf* -5 variety fingermillet			
	9%	11%	13%	15%
Threshing efficiency (%)	77.20	79.20	78.20	76.50
Winnowing efficiency (%)	87	90	89	88
Breakage (%)	2	1.7	1.5	1.5
Cost of threshing per quintal of grain (Rs.)	2.93	2.20	1.95	2.79

(Ramkumar *et al.,* 1988)

The cost of threshing is more and also slow process with less output. Kammar *et al.* (2001) observed that, there was a mechanical damage of 0.13-0.60% in manual beating, when the seeds threshed at three seed moisture levels (10, 13 and 18%). Lower seed moisture content recorded a higher mechanical damage and less germination of finger millet cultivars MR-1 and HR-911 in the manual beating with a stick.

Passing stone roller with bullocks:

Most of the farmers use this method (60%). Threshing of finger millet whole crop or ear heads is done with this method. It is faster than other two methods and suitable for large scale threshing. It requires a designated threshing yard. Threshing yard is prepared in a portion of the farmland by compacting the soil. It involves animal and human drudgery. It takes around four days to thresh the finger millet crop grown in one acre of land if only bullocks are used. This comes down to two to three days if granite rollers are used. It needs separate winnowing and cleaning operations and winnowing is depending on natural breeze. This method is limited to farmers owning bullock and threshing yard. Lots of wastage in threshing yard due to rains, birds, ants and other natural vagaries.

Passing bare tractor/ tractor with stone roller:

Threshing of finger millet by passing bare tractor / tractor with stone roller estimated to practiced by 30 per cent of the farmers. It also a faster method of threshing. We can thresh either whole crop or ear heads with a higher output capacity and is limited to availability of tractor and threshing yard. Here also winnowing and cleaning are required after threshing. Wastage in threshing yard is more as broken grains and other wastages. It takes

Table 4 : Comparative performance of different methods of threshing finger millet variety MR-1

Method of threshing	Type of feed	Out put capacity (kg/hr)	Broken (%)	Un-threshed grains (%)	Threshing efficiency (%)	Recovery (%)	Germination (%)
Threading under men feet	Ear heads	8.16	0.00	2.73	97.26	97.36	95.67
Hand beating manually	Ear heads	22.16	1.50	1.78	98.22	98.10	94.67
Passing stone roller with bullocks	Whole crop	96.8	1.65	4.96	94.35	95.13	94.67
	Ear heads	166.3	2.17	3.26	96.74	97.45	93.67
Passing bare tractor	Whole crop	116	3.10	7.68	92.30	92.23	94.67
Passing tractor with stone roller	Whole crop	119.33	3.20	5.98	93.98	94.45	94.33
	Ear heads	253	1.66	2.73	97.26	97.91	93.67
Proto type thresher	Ear heads	69.50	2.00	4.90	95.00	86.10	90.00

(Jayapalaiah, 2000)

around one day to thresh the finger millet crop grown in one acre of land. A study conducted by Kammar *et al.* (2001) by passing a tractor-drawn stone roller at 3 seed moisture levels (10, 13 and 18%), on mechanical damage and germination of finger miller cultivars MR-1 and HR-911, resulted in the highest mechanical damage (1.70-3.90%). There was no significant difference in mechanical damage to seed between the 2 cultivars in the threshing methods. The seeds threshed at lower seed moisture content recorded a higher mechanical damage compared to those threshed at higher seed moisture content.

Threshing on tar roads:

Threshing on roads accounts very small percentage (10%). The crop is spread at a depth of 4 to 6 inches on the road where there is fair density of moving heavy vehicles. The spread stays on the road for around six hours. Threshing will be done by rubbing action of the wheels, some amount of winnowing occurs automatically due to the momentum of the vehicles. The rest is winnowed later. Threshing time is depend upon density and type of vehicular traffic. An acres harvest could be threshed in approximately 6 to 7 hours if there is fair density of moving vehicles. This method is being cheaper, used by marginal farmers, farmers who do not have adequate family labour, or farmers whose land are located near the main roads or farmers who harvest in advance of the normal season. Even though the loss of grain is insignificant, but the grain quality is not so good and there is contamination of various kinds on the grain (Satish Chandra, 2006).

Mechanical threshing:

In recent years threshing of finger millet is by using mechanical threshers, it is suitable for threshing finger millet whole crop or ear head, subjected to availability of threshers. It does not require any threshing yard, output capacity is high. Cost of threshing is cheaper than all other methods, because all the three operations of threshing, winnowing and cleaning are performed in single operation. The efficiency of thresher is less when whole crop is fed to the thresher than the ear heads. The unthreshed grains and broken grains are more in case of machine threshing when the whole crop is fed to the mechanical thresher. Ramakumar *et al.* (1988) evaluated the rasp bar type thresher for ragi threshing and found 1100 rpm cylinder speed and 4 mm concave clearance found to be satisfactory for threshing whole crop of finger millet at 11-13 per cent (db) moisture (Table 3). The seeds threshed at lower seed moisture content recorded a higher mechanical damage compared to those threshed at higher seed moisture content (Kammar *et al.,* 2001). Threshing studies conducted by Narayanaswamy and Javaregowda (1989) in "Almaco" plant and earhead thresher reveals that, irrespective of the variety both the threshing efficiency and mechanical damages were decreased with decrease in cylinder speed and the mechanical damages were higher at higher speed and decreased with decrease in cylinder speed. The decrease in germination and vigour index with increase in cylinder speed was observed. Decrease in germination is due to greater impact force on the seed. The threshing efficiency, germination percentage and vigour index were found to be optimum with the ragi ear heads threshed at the cylinder speed of 1295m/min at a moisture range of 20-22 per cent (Table 2).

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