

Manuring of Millèts in Madras

By

P. KRISHNA RAO & A. KUNHIKORAN NAMBIAR
(Millets Section, Agricultural Research Institute, Coimbatore)

Millets are small-grained cereals which are very ancient in origin. They have served as food for man and his domesticated animals from prehistoric times. Growing wild in virgin soils, they yielded grain and fodder to the nomadic ancestors of the present civilised nations. Later on, settled life and pressure of population induced cultivation and selection, and innumerable varieties and forms came into existence. The important millets that are under cultivation are Sorghum (*Cholam* or *Jonna*), *Pennisetum typhoides* (*Cumbu* or *Sajja*), *Eleusine coracana* (*Ragi*), *Setaria italica* (*Tennai*), *Paspalum scrobiculatum* (*Varagu* or *Arika*), *Panicum miliare* (*Samai* or *Samalu*), *Panicum miliaceum* (*Panivaragu* or *Variga*), and *Echinochloa frumentacea* (*Kudirai vali*). Millet grains take no part in international commerce as they are the food of the poorer classes of people, and are very little cultivated in the more advanced agricultural regions. However, millets form the staple food of a quarter of the world's population of 2,000 millions, and they are the dominant cereals in the whole of Africa except the north, and that they are the mainstay of the population of Africa, China, Manchuria and about 30% of the population of India. Their importance is also enhanced by the fact that they have certain advantages over the other cereals. Some of them, particularly the Panicums, grow very rapidly and ripen more quickly than any other cereal and are hence suited to areas where the rainy season is short. Most of them thrive in arid regions and resist drought in a remarkable way. They flourish on land which is too thin or too poor to grow any other cereal, require less attention and have fewer pests than rice, wheat, maize etc. All of them are richer than rice and wheat in fat and minerals, while some are richer than wheat in protein also. All these facts point to their high status as important sources of human food and cattle fodder in the hotter and drier regions of the world. (In India, they occupy about 64 million acres with an annual production of 12 million tons of grain, while their area in the Madras State is 12.8 million acres, the annual grain production being 3.2 million tons. In Madras, 30% of the population and 60% of the cattle are entirely dependent on millets. Hence the importance of millets can never be over-emphasised.) In this State too, however, they have not received adequate attention, particularly with regard to manuring. A brief review of the outstanding results achieved in the State through manuring, and some recommendations are presented in this paper.

Place of Millets among manured crops: Manure is the index of the commercial or economic importance of any crop, and the care with which the required quantity and quality of manures is applied directly reflects the esteem in which the crop is held by the farmer. Thus sugarcane, bananas, tobacco etc., among commercial crops, and paddy, wheat, maize etc., among grain crops are invariably manured and the farmer pays much attention to them. But, millets, being the poor man's crop and commercially of much less importance, are not generally manured. There are other reasons also. The bulk of the millets, nearly 90% of the total area, are rainfed and are subject to the vagaries of the monsoons,

thus imposing limitations to the application of manures. The best effect of manure can be obtained only when sufficient water is available. The quantity of manure available for all crops is another limiting factor and the more important crops invariably get the available manures. The vast majority of the millets, particularly the rainfed crops, are sown in rotation or mixed with pulses and other leguminous crops, and the atmospheric nitrogen fixed by the latter is a source of nitrogen to the cereal. Where millets follow a commercial crop, particularly under irrigation, the heavy dose of manure applied to the previous crop is expected to leave sufficient residual effects to sustain the millet crop. Thus, due to various reasons millets do not receive adequate manuring, and the maximum yields of grain and straw that can be obtained from this group of crops are never realised in this State.

Response of millets to manuring: Millets are a group of crops which respond very well to manuring. Both rainfed and irrigated crops can be manured with advantage, if adequate moisture is available for the crops. Unlike sugarcane, paddy etc., millets require much less water and can thrive on a variety of lands where paddy and other grain crops cannot be successfully grown. Hence with the same amount of manure and water, a much heavier harvest of grain and fodder can be obtained from millets than from other cereals. Unfortunately this fact is neither well known nor its significance fully realised to derive benefits through its practical application. Experiments conducted at the Research Stations in this State have clearly established that millets respond very well to the application of both organic manures and also artificial fertilizers, paying a handsome return for the expense and trouble involved especially with irrigated millets. Rainfed cholam manured at 2 cwts. of ammonium sulphate and 1 cwt. of super phosphate with or without a basal dressing of 5 cartloads of cattle manure (2½ tons) per acre gave 67 to 72% increased yields over the control. These experiments were conducted at the Agricultural Research Stations, Guntur, Hagari, Nandyal and Koilpatti. Apart from the artificial manures, the application of green manures viz. *Pillipesara*, *Tegapesara* or cowpea was tried for a period of three years with and without superphosphate on *Pyru Jonna* at Guntur. All the three green manures gave 40 to 60% increased yields over the control, cowpea proving to be the best green manure. The application of molasses at 8 tons per acre at Hagari resulted in an increased yield of 100% over the control. The effect of ammonium sulphate and groundnut cake individually and in combination at different levels of nitrogen over a basal application of 1 cwt. of superphosphate and 1 cartload of cattle manure per acre were studied at Koilpatti. It was found that the application of nitrogen either as ammonium sulphate or a mixture of both resulted in increased yields going upto 144% over the control at the highest level of nitrogen as groundnut cake. The residual effects of ammonium sulphate at 2 cwts, and superphosphate at 1 cwt applied to cotton, over a basal dressing of 5 cartloads of cattle manure per acre, were tested both on *Pyru jonna* grain and fodder crops over a period of two years at the Agricultural Research Station, Guntur. The artificials, in combination with cattle manure proved better than cattle manure alone with increases in yield of 20 and 15% respectively. Similar results were obtained at Hagari, Nandyal and Koilpatti also. These residual effects were traced even to the second year with increases in yield ranging between 10 and 18%. Similar experiments were conducted on *cumbu* at Koilpatti with varying

doses of groundnut cake, ammonium sulphate and superphosphate over a basal dressing of 6 cart loads of cattle manure per acre. All the treatments gave significant increases yield over the control, 2 cwt.s. of ammonium sulphate giving the highest yield. Very encouraging results have been obtained from the application of fertilisers to ragi. Experiments conducted on korra (tenai) at Hagari showed that the application of Indore compost and farmyard manure to supply 50 lb. of nitrogen per acre was highly beneficial and resulted in increases in yield ranging from 26 to 35% over the control. In another experiment, the optimum dose of farmyard manure was found to be 6,000 lb. per acre and gave 28% increase of grain yield over the control plot. A dose of 50 lb. of nitrogen in the form of farmyard manure, compost or artificials, has also been found to give very high yields in all the minor millets - varagu, samai, panivarugu, and kudiravali. These experiments have been reviewed and the results summarised in the Madras Agricultural Journal Vol. XXXII, Nos. 1 to 4. An abstract of the results obtained at the different research centres in this State is given in Table. 1.

Abstract of Results of Manurial experiments conducted on Millets in the Madras State

Name of crop	Centre of trial	Manure applied (per acre)	Increased yield (as a percentage over control)	Remarks
(1)	(2)	(3)	(4)	(5)
Rainfed cholam (Jouna):				
Grain crop	Nandyal	Artificials with or without cattle manure (at 5 C. L.)	55	
"	"	Am. Sulph. 80 lb.	43	Control not manured
"	Hagari	Am. Sulph. 2 cwt. & Super phos. 1 cwt.	72	Control not manured
"	Lam (Guntur)	do	67	Control manured at 5 C.L. of cattle manure
"	"	Pillipesara, Tecgapesara or Cowpea.	40-60	
Fodder crop	"	Am. Sulph. 2 cwt. & Super phos. 2 cwt.	93	Control 5 C. L. of cattle manure
Irrigated cholam:				
Grain crop	Hagari	Molasses at 8 tons	100	Control yield 318 lb.
"	Central Farm, Cbc.	Am. Sulph. 2 cwt. & Super phos. 1 cwt.	63	
"	"	Artificia's (Am. Sulph., Super phos.) with a basal dressing of cattle manure	25-62	
"	"	Do. without basal dressing of Cattle manure	4-205	

Name of crop	Centre of trial	Manure applied (per acre)	Increased yield (as a percentage over control)	Remarks
"	Koilpatti	G. N. Cake with Am. Sulph.	123-144	
"	"	Do. with cattle manure & cotton compost (6 C. L.)	226	
"	"	Cattle manure, & Am. Sulph. 2 cwt. & Super phos 1 cwt.	352	
Fodder Crop	"	Nitrolime 2 cwt., fish guano 5 cwt., singly & in combination	41-61	No manure control
"	"	F. Y. M. and G. M. cake & Articials (Am. sulph & super phos)	19-157	
Cumbu Grain crop	"	Nitrolime 2 cwt. & Super phos $\frac{1}{2}$ cwt	44-73	
"	"	6 C. L. of F. Y. M. (Basal) & G. N. cake (125 to 250) plus Am. sulph. & super phos. (artificial $\frac{1}{2}$ to 2 cwt)	60-160	Control manured at 6 Cart loads Farm Yard Manure.
Fodder crop	"	Am. sulph. 2 cwt; & super phos. $\frac{1}{2}$ cwt.	14-120	
"	"	Am. sulph. 2 cwt.	70	
Irrigated Ragi:				
Grain	Palur	Indore compost & F. Y. M. to supply 80 lb. of nitrogen each	37-53	Control no manure
"	"	Am. phos. 1 cwt. & 5 C.L. cattle manure	31	Over 5 C. L. cattle manure control
"	Central Farm Cbe.	Artificial to supply N. K. etc. either singly or in group with or without cattle manure	7-72	
Rainfed Tenai:				
Grain crop	Hagari	Indore compost or F. Y. M.	26-35	Control no manure 320 lb. grain.
"	"	F. Y. M. at 3,000, 60,000, & 9,000 lb.	20-30	Control no manure 380 lb. grain.
Irrigated Panivaragu:				
Grain crop,	Central Farm Cbe.	Cattle manure at 5 C. L. per acre	23	Control no manure

Abbreviations used indicate the following :

Am. Sulph.	Ammonium sulphate	Super. phos.	Superphosphate
C. M.	Cattle manure	C. L.	Cart loads
F. Y. M.	Farmyard manure	G. N. cake	Groundnut cake

It will be seen from the above table, that millets respond very well to manuring and that profitable returns can be obtained by the application of organic manures as well as artificial fertilizers.

Manures suitable to Millets : There is a large variety of manures which are found suitable to millets. They fall into two groups, organic manures and artificial fertilizers. Under the organic manures may be listed the manures obtained from the livestock kept on the farm, compost made on the farm, municipal rubbish and other refuse decomposed and converted into manure, compost made with night soil, dung, urine, etc., applied to the field direct by sheep-penning and cattle penning, oilcakes, bonemeal etc. Amongst the artificials, the commonest fertilizers now in use are ammonium sulphate, super phosphate, etc. In addition to these, green leaves, dry leaves, earth from old village sites, red soil from fertile spots, tank silt etc., are also applied to the fields to enrich and improve them. Depending upon the availability of these manures and fertilizers and the agricultural practices prevailing in the different tracts, different manures may be applied to the various millets cultivated in the State. (The primary consideration in the application of manures is to put back into the soil what is removed in the form of grain and straw. Large quantities of nitrogen and phosphoric acid and potash are required for obtaining high yields of most crops.) Millets are largely grown as dry crops which are completely dependent upon rains. As already stated, nearly 90% of the total area under these crops are completely rainfed, and subject to the vagaries of the monsoons, while the remaining area is cropped with the help of irrigation. (The irrigated millets are invariably manured directly or indirectly in all parts of this State, and depending upon the availability, cost and other factors, varying quantities are applied.) While only organic manures such as cattle manure, compost, etc., were applied in olden days, the need for and the advantages of incorporating heavy doses of both organic manures and artificial fertilizers have been realised of late by the gardenland cultivators, and manuring has become a regular practice in the garden lands in the central and southern districts of this State. Apart from these manures, heavy doses of tank silt, poudrette, compost etc., are also applied. Among the irrigated millets, *Ragi*, *Cholam*, and *Cumbu*, are the most important and they receive the bulk of the manures. *Tennai*, and the minor millets are also grown under irrigation here and there, and they are also occasionally manured with artificials along with the organic manures. The manuring of the rainfed millets, on the other hand presents many difficult problems connected with season, availability of manures, economic position of the farmers, etc. In the first place, while the organic manures like cattle manure may safely be applied to the drylands, it is not available in adequate quantities to meet the needs of the dryland farmers. Hence its application is considerably restricted, and in some tracts, manure is added only once in two or four years, while in other tracts, the practice is completely given up. The next problem is the precarious nature of the monsoon, with the result that if the season fails, the benefits of manuring are not realised, and the crop is a failure.

Though artificial manures are available to supplement the shortage in organic manures, they cannot be safely applied to the rainfed crops in those tracts where the rainfall is low or precarious. If the season fails, not only do the artificials become infructuous, they do positive harm and the crops dry up in patches in unfavourable seasons. Hence artificial fertilizers like ammonium sulphate, superphosphate, potassium sulphate etc., should be applied to rainfed millets, only in those tracts where the rainfall is dependable, well distributed and adequate for the successful growth of such crops. A very valuable and safe manure for such lands is the compost made from night soil and town waste which are at present almost thrown away in our country. A beginning in this direction has been made in the large municipalities of our State, and the great value of poudrette as a source of manure, has been realised. But further work is required in this direction.

As with manures, great variations are met with in their dosages and also methods of application. Depending upon the availability, heavy doses are applied in some districts. The organic manures are invariably incorporated before the field is prepared for sowing or planting. Sometimes it is sprinkled in plough furrows along with the seeds. The artificials, on the other hand, are applied in one or two doses after the crop is sown or planted. The results of trials conducted in the Permanent Manurial plots at the Agricultural Research Institute, Coimbatore on irrigated *cholam* and *ragi* indicate that joint application of nitrogen and phosphoric acid increase the yield in all cases. Large responses are noticed in the case of plots continuously manured with cattle manure. It is also indicated that phosphoric acid is an essential supplement to nitrogen. From the experiments conducted in this State, the following conclusions may with advantage be adopted in the cultivation of millets.

(i) Continuous manuring of fields with cattle manure gives good response and increases the yield of millets. It builds up soil fertility.

(ii) A joint application of ammonium sulphate at 2 cwt. and superphosphate at 1 cwt, over a basal dressing of farmyard manure at 5 cartloads per acre, is more effective than applying each of them alone.

(iii) Phosphates are an essential supplement to nitrogen and maximum benefit can be obtained from nitrogenous fertilizers only with the addition of phosphatic manures.

(iv) Among the several sources of nitrogen, ammonium sulphate is the best for millets.

(v) In the case of dry crops, if the rainfall is not normal and adequate, there is a depression in yield after the application of inorganic nitrogen, and adequate response is not found in the case of phosphates also.

(vi) The economic doses of nitrogen, phosphoric acid and potash that are to be applied to different types of crops vary considerably and have to be fixed with reference to soil and climatic conditions. Application of fertilizers to supply 30 lb. of nitrogen and about the same amount of phosphoric acid are considered adequate for rainfed crops and 50% more for the irrigated crops in this State. *Ragi* alone requires heavy doses of potash. The others require only light doses. Higher doses of all these fertilizers lead to wastage and become uneconomic in the end.

Economic possibilities of manuring millets: (That millets respond very well to manuring and give profitable returns) has already been pointed out. As millets occupy nearly 13 million acres in this State, the economic possibilities of obtaining increased production from these crops through judicious use of fertilizers and organic manures are enormous. Among the major millets, *ragi*, *cholam* and *cumbu*, are heavy yielders under favourable conditions. More than 57% of the total area under *ragi*, 12% of *cholam* and about 12.5% of *cumbu* are irrigated, and offer the greatest scope for the application high yielding fertilizers. About a lakh of acres of the other millets i. e. about 3% of the total area, are also grown under irrigation, and if properly manured they also will give high yields. Thus 19 lakhs of irrigated millets are available for proper manuring. The major portion of the millet acreages are, however, rainfed and the application of artificial fertilizers is neither feasible nor possible in all cases. But the maximum yields from such lands also, could be obtained through the application of organic manures, which give better results than the artificials under adverse conditions. A rough estimate of the economic results of manuring both rainfed and irrigated millets is given in a tabular form below. To obtain the best results from manures, the fundamental principles generally to be observed in the use of fertilizers have to be borne in mind. Briefly stated, the crop returns from the use of fertilizers depend on many factors other than the kind of fertilizers selected. All fertilizers give the best results, if their use is combined with good soil, good tilth, adequate doses of all fertilizers, optimum moisture, proper time of sowing, improved seeds and efficient crop management. Since equivalent amounts of fertilizers give more or less the same yield, their relative cost is also an important consideration in working out the economics of manuring.

As the cost of fertilizers as well as that of the produce varies from season to season, neither the expenditure nor the money value of the increase in yield is indicated in the following table. The figures will however show the increased yields that can be obtained and the enormous possibilities of manuring these small-grained cereals and realising higher yields.

Table showing the possible increases in yield from millets as a result of manuring

Name of Millet	Area in lakhs of acres		Total increased production (in tons)		
	Rainfed	Irrigated	Rainfed	Irrigated	Total
Cholam	43	5	2,05,000	1,67,000	3,72,000
Cumbu	23	3	1,18,000	80,000	1,98,000
Ragi	7	10	90,000	3,34,000	4,24,000
Tenai and Minor Millets	Rainfed and Irrigated } 36		Rainfed and Irrigated }		64,000
Total					10,58,000

Notes: 1. The normal yields given in the Season and Crop Reports (1948—1949) are taken for calculation. They are 575 lb., 555 lb. and 720 lb. per acre for dry crops and 1,500 lb., 1,200 lb., 1,500 lb. for irrigated crops of cholam, cumbu and ragi respectively.

2. Manures recommended for application are 2 cwt. of ammonium sulphate and 1 cwt. of superphosphate over a basal application of 5 cartloads of cattle manure per acre.
3. The expected increase in yield has been taken at 40% in the case of rainfed and 50% in the case of irrigated crops. In the experiments conducted in the various Agricultural Research Stations in the Madras State, the application of different manures gave increased yields from 14 to 160% for rainfed crops and 90 to 200% in the case of irrigated crops.
4. The total normal area under *cholam* is 48 lakhs of acres of which about 43 lakhs are rainfed and the rest irrigated. Out of this 43 lakhs, about 20 lakhs of acres will be classified as suitable for the application of manures including artificials. Hence this area alone is taken for estimating the increased yield that can be obtained from this crop.
5. In the case of *cumbu*, out of 26 lakhs of acres cultivated, 3 lakhs are irrigated and the entire area can be manured with advantage. Of the remaining 23 lakhs of unirrigated area, 12 lakhs are taken as capable of being manured.
6. In the case of *ragi*, it is taken that the entire area can be manured. Out of the total area of 17 lakhs of acres, 10 lakhs are irrigated and 7 lakhs rainfed.
7. *Tennai and minor millets* together occupy about 36 lakhs of acres and about 25% of this area or about 9 lakhs are capable of being manured under unirrigated or irrigated conditions.

It has been estimated that an additional production of one million tons of millets can be obtained by a scheme of intensive manuring of millets in the State and the provision of sufficient quantity of manures.

Conclusion: The value of millets as the premier dryland crops of this State is known to every farmer. But due to various reasons, the maximum yields that could be obtained from these crops are not realised. Apart from the use of improved strains, one of the easiest ways of increasing the yields is by the application of manures. This is particularly possible in the case of the irrigated millets which are grown over 19 lakhs of acres in the State. With proper manuring and irrigation, very heavy yields can be obtained from most of the millets, particularly *ragi*, *cholam* and *cumbu*. The yields of the rainfed crops of millets, can be increased by the application of organic manures, and also artificial fertilizers in those districts, where the rainfall during the growing period of the crop is adequate and well distributed. From the results of the experiments conducted in this State, the types of manures that give the best results and possible increases in yield that can be obtained through their application have been indicated. It has been estimated that in millets increased production of a million tons could be obtained in the State by a scheme of intensive manuring of millets and the provision of necessary quantities of manure for the purpose. Further investigations are necessary to fix the precise economic doses of these fertilizers for the different regions.