Milk Production. Up to the present we have dealt mostly with work cattle. The necessity for improvement of cattle for milk production cannot be overlooked. The Coimbatore District Board has already accepted a scheme for placing at stud Scindhe and Delhi buffalo bulls.

With increased industrialisation in large centres like Coimbatore, a larger number of people will cease to have any connection with the land. Nutrition experts point to millk as one of the most essential and perfect foods, The first stage in increased milk supply is the breeding of stock which will produce more milk. The question arises as to where such bulls should be stationed. Some say in the larger towns, others in the villages. Possibly at the present time, there are more milk cows in the larger towns than in the districts and to serve these cows the bulls should be placed there. But what about the calves? In towns they certainly do not get the attention or food required. It is also probable that as the Health authorities become stricter, the number of cows maintained in the larger towns will be decreased on the score of health and cleanliness. In the near future therefore, it is likely that the villages in the neighbourhood of large towns will become the dairy industry and dairy stock breeding centres and milk and milk products only will be transported to the large centres.

The displacement of work cattle by power for lifting water etc., will make room for milk cattle and these will produce the essential Farm yard manure to maintain soil fertility and at the same time pay for themselves by production of milk.

INHERITANCE OF GRAIN SHATTERING IN RICE

(Oryza sativa).

By K. RAMIAH & K. HANUMANTHA RAO

Introduction. Shedding or shattering of grain is an important economic character in rice. In cultivated rices this causes a serious loss during harvest and the loss is estimated to vary according to the locality and the varieties, from as low a figure as 5% up to 30%. The firmness with which the ripe grain is attached to the rachis varies widely in different varieties. Wild rices exhibit this character to the maximum extent, the grains here falling away at the slightest impact of wind, even before they are fully ripe. In certain provinces where the cultivated rices get hybridised with wild rices through natural agencies the problem of shedding becomes a serious one. Some of the progenies of these crosses look for all practical purposes like the cultivated types but have the badly shattering character of the wild rice in them. Since it is not usually possible to identify them and eliminate them in the early stages, they form a permanent source of deterioration of the crop. Bhalerao (1930) surveyed Mallnad tract of the Southern Division in the Bombay Presidency and has suggested remedial measures against these 'Gonags' or cultivated rices showing this wild character.

Among the cultivated rices, in some, the grains fall off very easily in the field itself during harvesting operations, while in others, like some of the Burma types in our varietal collection, the grains are so firmly attached to the rachis that threshing becomes a difficult operation. The ideal variety of rice should be one that does not usually shatter in the ordinary process of harvesting but at the same time lends itself to easy threshing. The study of the inheritance of this economic character was taken up at the Paddy Breeding Station in the years 1932—34.

Literature. The inheritance of this character where both the parents belonged to the cultivated types has not been reported so far. But when one of the parents is a wild type, it has been found (unpublished records of the Paddy Breeding Station) that this behaves as a simple mendelian character, the shattering being a recessive rudiment.

In his anatomical studies, Yoshito (1928) has shown that shedding is due to the formation of a special abscission tissue in the part of the stalklet which lies between the empty and the glume rudiment. The time at which this tissue is formed varies with varieties. In some this tissue is formed very early and dries up before the panicle ripens and this premature drying up causes the grain to shed before the harvest. In others, this tissue begins to form long after they have flowered, and the crop is harvested even before this tissue gets fully developed. The time of formation of this abscission layer thus determines the nature of shedding.

Estimation of shedding character. (a) *Device.* The estimation of the degree of shedding, a quantitative character, is not quite easy. The only recorded attempt to measure this character quantitatively is that reported by Mendiola (1926). The principle of this method consists in dropping the rice panicle from a definite height over a wire mesh, the degree of shedding being measured by the number of grains shed from such an impact. The method of dropping involves difficulties in controlling the way in which the panicle falls, as the surface of impact of the panicle cannot always be the same.

The study of a number of families for the inheritance of this character led to the improvisation of a simple apparatus designed by the Junior Author (1935) and it has been found to give satisfactory results. The apparatus consists of an inclined plane over which the panicle to be tested for shattering is placed at a definite distance from the top edge and a weighted roller which is allowed to pass over the head. The number of grains shattered by the roller passing over the panicle is a measure of the shattering.

(*b*) *Materials and Method.* A preliminary rough examination of all the pure lines grown at the Paddy Breeding Station, was made to distinguish the shedding and non-shedding types. When the degree of shedding is expressed as a percentage of the shed to the total number of grains in a panicle, the number of grains shed and the total number of grains on the panicle have to be counted each time which involves considerable amount of labour. The only method of eliminating this difficulty was to select such parents for crosses which though they varied with regard to shattering, had about the same size and number of grains in the panicle. In the study of the families involving parents having such uniform panicles, the actual number of grains that shed was taken as an index of the measure of the degree of shedding.

The next step was to decide the minimum number of plants and the minimum number of ear heads in each plant that would have to be examined which would give a correct estimate of the whole family for the character. After some preliminary tests it was found that the shattering measured in one of the main panicles in each of 25 plants in a family gave a correct estimate of the character of the family.

There is also another difficulty which should bring in an error in the estimation namely that due to the degree of ripeness of the grain. Obviously for the measure of the character, panicles of the same age have to be examined. Since ripening depends upon the time of flowering the flowering dates of each plant were recorded in each of the families and the panicles were collected exactly 40 days after flowering, when the grains were found to be ripe.

The procedure adopted for the estimation of this character was as follows. The first thing was to mark the detailed flowering of the individual plants on a chart. By referring to this chart, plants, that flowered 40 days earlier were spotted out in the field. One primary earhead from each of those marked out plants was cut just below the neck or the ring of the panicle, early in the morning. All the earheads were carefully labelled and were uniformly dried in a tray for four hours. They were then placed over the apparatus one by one and the roller was passed. The number of grains shattered in each panicle was taken as the measure of the degree of shattering.

Inheritance Studies. *Parents.* One of the parents selected was T. 237, a non-shedding type where the number of grains shed ranged from 0—10 with a mean of $3{\cdot}54 \pm 0{\cdot}13$. The other parent was T. 389, a highly shedding type where the grains shed ranged from 17—56 with a mean of $34{\cdot}30 \pm 0{\cdot}53$ grains.

F_1. A cross was made between the above two parents T. 237 xT. 389, in the year 1931—32, and in 1932--33 the F_1 plants were grown. Since the device mentioned had not been perfected when the F_1 was ready, the degree of shattering was estimated only by beating the head

Table I.

Frequency of number of grains shed in F_2 and parents. (1933—34).

	Number of grains shed.															Total.	Mean number of grains shed.
	Nil.	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56		
Parent T. 237	4	66	24	1	—	—	—	—	—	—	—	—	—	—	--	95	3·54 ± 0·1302
F_2 4482	-	59	134	108	104	63	30	24	7	5	1	2	—	—	--	537	12·34 ± 0·2057
Parent T. 389	-	—	—	—	—	5	10	17	13	18	14	12	9	3	3	104	34·30 ± 0·5344

Table II.

Statement showing the correlation betweeen the number of grains shed in F_2 and the mean number of grain shed in F_3 progenies.

Mean number of grains shed in F_3 progenies.	Number of grains shed in F_2.																					Total
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	
1—2			1																			1
3—4	1	10	8	12	6	2	2				1											42
5—6	11	16	20	15	13	13	11	6	4	4	...	2	1									116
7—8	6	11	16	21	14	9	14	17	7	4	2	...	2	2								125
9—10	1	3	10	9	15	13	13	9	12	5	5	4	4									103
11—12	...	2	2	3	6	5	6	6	9	3	5	1	3	3	1	1	1	1	...	...	1	59
13—14	...	...	2	...	2	...	1	3	4	7	1	2	4	...	1	1	...	...	...	1	...	29
15—16	...	...	...	2	...	...	1	5	...	2	...	1	1	...	2	1	...	...	...	...	1	16
17—18	...	...	...	2	...	...	1	...	...	...	3	...	1									7
19—20	...	...	...	...	1	1	...	...	...	1	...	2	2	...	...	...	...	1				8
21—22																		1				1
23—24																						...
25—26																						1
27—28																						1
Total.	19	42	59	64	57	43	49	47	37	26	17	12	18	5	4	3	1	3	...	1	2	509

Parental means.		F_2	F_3
	T. 237	3·5	2·9
	T. 389	34·3	25·0

Correlation $r = + 0·48 \pm 0·023$.

on the palm and it was found to be intermediate between the two parents.

F_2. In 1933—34 all the seeds from one of the selfed F_1 plants were sown, and 600 F_2 seedlings were planted in lines one foot either way. 150 plants of each of the two parents were also planted in lines on either side of the F_2 population. Detailed flowering was marked for all the plants individually. Shedding was estimated as described already. The results obtained are given in a tabular statement (Table I).

F_3. In 1934—35, the whole F_2 population was carried forward for the study of F_3 behaviour. In each lot, 100 plants were planted in three rows 1′ apart and 6″ in the row. Here also general flowering was marked for individual families and the estimation of shedding was done with reference to those dates. 25 plants were examined in each family.

From the readings collected, first the mean number of grains shed in the F_3 families, the standard error and the percentage standard error were calculated. The coefficient of correlation between the number of grains shed in F_2 and the mean number of grains shed in the respective F_3 families was determined (Table 2).

Analysis and Conclusion. F_2 ratios do not indicate any simple inheritance. The mean number of grains shed per panicle for the two parents are 3·54 and 34·3 respectively whereas the F_2 mean is 12·34, intermediate and tending towards the nonshedding parent. The greater variability and the distribution of the F_2 population indicate that more than one factor is involved in the inheritance of this character.

In the F_3 we find that there is a significant positive correlation between the number of grains shed in F_2 and the mean number of grains shed in F_3, the coefficient of correlation, r, being $+0{\cdot}48 \pm 0{\cdot}023$. This is an indication that the factors involved in the inheritance of this character are not many.

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