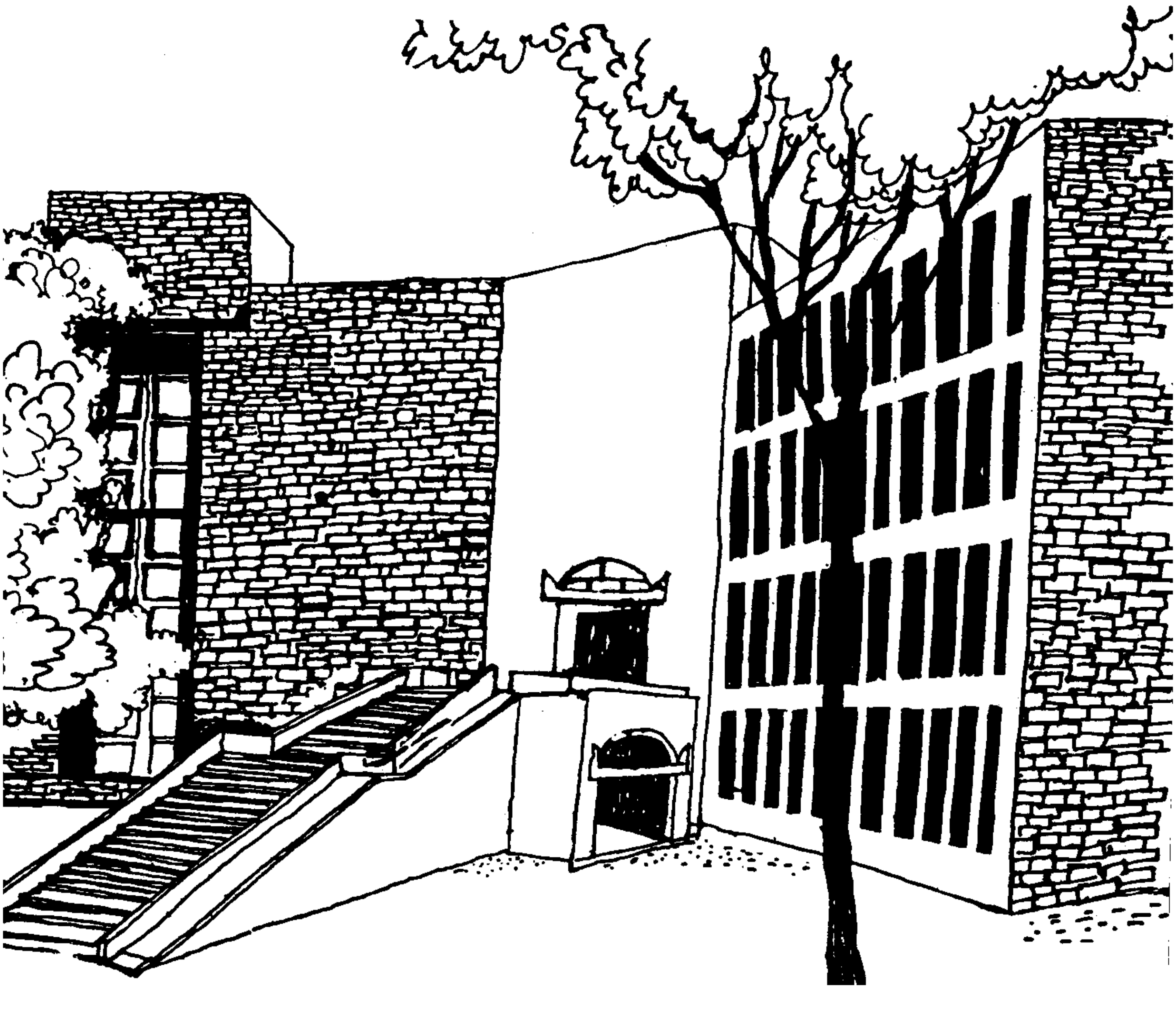
विद्याविनियोगाद्विकासः

IIM AHMEDABAD

Working Paper



SEED REPLACEMENT RATE: SOME METHODOLOGICAL ISSUES

By

Gurdev Singh
&
S. R. Asokan

W P No. 1065
November 1992

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

ABSTRACT

Ideally seed should be replaced every year for hybrids and every three to four years for non-hybrids. However, in practice seed is replaced less often especially in case of open pollinated crops. As a consequence, seed replacement rates are lower than recommended for different crop varieties. As adequate information is not available on replacement schedules followed by farmers, how to compute actual replacement rates? One simple method is to take ther ratio of quality seed of a crop produced during the year to the total seed needed to cover the entire area under the crop. This method does not consider the crop produce from F_2, F_3 and F^4 generations distributed as seed among the fellow farmers. This paper presents an alternative model which considers such lateral distribution of seed from successive generations of a variety. The model gives more precise estimates of replacement rates for better planning of seed production activity and is thus named as "improved model".

SEED REPLACEMENT RATE : SOME METHODOLOGICAL ISSUES

Gurdev Singh and S.R.Asokan

Quality Seed

Seed may be defined as a multicellular structure consisting of live embryo, stored food and seed coat and is derived from fertilised ovule by which flowering plants reproduce. The seed under congenial conditions of temperature and moisture germinates and grows into a plant identical to its parents. Quality seed is physically stout with specific moisture content, genetically true to type and near 100 per cent germination. Certified seeds are systematically tested for their purity and germination by the seed testing authorities at State/Central laboratories. Similarly truthfully labelled seed is tested by the individual seed enterprises at their own laboratories. So certified seeds and truthfully labelled seed are quality seed. As F_2 to F_4 generation produce of varieties used as seed gives satisfactory results at field level, it is treated as quality seed. Even beyond F_4 generation if the seed is produced by the farmers with sufficient care at different stages it may also be treated as quality seed.

Seed Replacement Schedule

Normally for a variety crop produce from successive years is used as seed for a number of years. The old seed (retained crop produce) is replaced when either a new variety seed with higher yield potential is available, or the old seed deteriorates in quality such that its expected productivity is much lower than the potential or normal. The deterioration in quality may occur due to physical admixtures or loss of genetic vigour and germination power of the seed. The admixtures may occur in the field, at the thrashing yard or even in storage when seed of other varieties, crops or weeds get mixed with the variety. The genetic impurity may result from unwanted crosses, segregation of some dominant characters, accidental mutations, etc. These may result in loss in germination and reduced productivity. The germination percentage may also go down due to physical damage to seed such as broken seed, moisture affected seed, insect and fungal infestation of seed etc. Nevertheless, the farmers decision to replace seed would depend upon what he gains from the replacement and at what cost i.e. net incremental gains. In other words, the farmers decide to replace old seed with fresh lot (certified or quality seed) when the expected loss in yield (in value terms) exceeds the net cost of using quality seed. The principle of partial budgetting forms the basis of the decision. The question thus arises that how often the farmers have to replace old seed. It has been established that large scale deterioration in genetic purity of seed occurs in F_2 generation of hybrid seeds because of segregation of characters. Therefore, hybrid seed must be replaced every year or 100 per cent replacement is needed every year. In the case of non-hybrid seed which are genetically stable, genetic deterioration is very slow.

However, admixtures could deteriorate its quality. Again it has been established on the basis of analysis of samples that such level of deterioration occurs beyond F_4 generation for most of the crops. Thus seed replacement becomes necessary after 4 years of use of successive generations of quality seed. This period for some crops like jowar, bajra is three years. However, if own seed production by the farmers is carried out in a systematic manner, the replacement period may be extended by a couple of years. With the advancement of plant breeding research continuous improvement in yield is achieved in almost all major crops. New varieties are evolved with higher productivity before the expiry of even first replacement cycle of existing variety. As such chances of old seed being used beyond their recommended replacement schedule are not many. Nevertheless, the facilities to produce sufficient quanity of quality seed of a new variety to replace the old variety on total area (target area) in one stroke does not exist and hence a good proportions of farmers continue using retained crop produce as seed for a number of years beyond the recommended replacement period.

Seed Replacement Rate

Seed replacement rate may be computed on the basis of recommended replacement period. That is, if replacement is to be carried out every year (for hybrids) the desired replacement rate is 100 per cent, if every alternative year, it is 50 per cent if three years, it is 33.3 per cent and if four years, it is 25 per cent.

In other words, sufficient quality seed should be available to cover 100 per cent, 50 per cent, 33.3 per cent and 25 per cent of the crop area to achieve these rates. However, it is rarely possible to produce adequate quantity of seed of any crop variety and there always exists a gap between seed requirements and seed availability. In other words, the actual replacement rates are lower than the desired replacement rates. But how to compute the actual replacement rates? In what follows is the estimation of seed replacement rates.

Simple Model

One simple method to estimate the seed replacement rate is to compute the percentage of the total area under the crop that can be covered with the quantity of quality seed produced or available for sowing for the commencing agricultural year, i.e.

$R = (S * 100) / (A * K)$

where

R = Seed Replacement Rate

S = Quality Seed produced during the year

K = Seed Rate per unit of area

A = Area under the crop

The denominator (K * A) gives the quantity of seed that would be required to cover the total area under the crop. Thus seed replacement rate is the quality seed available as per cent of total seed required for the target area. From this relationship, given the value of R, the quantity of quality seed needed to cover the whole area under the crop can be estimated as;

$$S = R * A * K/100$$

i.e., total seed required times replacement rate is divided by 100.

Using the above model the seed replacement rate is worked out for paddy and wheat and presented in Table 1.

Table 1 : Seed Replacement Rates for Wheat and Paddy, 1983-84 to 1988-89 Based on Simple Model

Year (1)	Cropped area (million hectare) (2)	Seed requirements (thousand tonnes) (3)	Seed produced (thousand tonnes) (4)	Seed replacement rate((4)*100/(3) (per cent) (5)
Wheat (seed rate: 100 kg/hectare)				
1983-84	24.7	2470	173	7.0
1984-85	23.6	2360	186	7.9
1985-86	23.0	2300	127	5.5
1986-87	22.8	2280	158	6.9
1987-88	23.1	2310	139	6.0
1988-89	24.0	2400	170	7.1
Paddy (seed rate: 30 kg/hectare)				
1983-84	41.2	1236	89	7.2
1984-85	41.2	1236	120	9.7
1985-86	41.1	1236	104	8.4
1986-87	40.8	1224	132	10.8
1987-88	38.8	1164	138	11.9
1988-89	41.8	1254	166	13.3

Improved Model

The above model does not consider the use of retained crop produce from successive generations and the lateral distribution of F_2, F_3, F_4 generation produce that may have been used as seed by fellow farmers. Hence the quality seed availability is under estimated to that extent. Since only a part of F_2, F_3, F_4

generation produce may be used as seed and information on such proportions is not available, it is difficult to arrive at precise estimates of quality seed availability. Nevertheless, we may conceptualise the model for its estimation under certain assumptions. Let

Si = Certified seed produced in the ith year

i = 1 to 4

Pi = Proportion crop produce from ith generation of seed available as quality seed i = 1 to 3

Z = Productivity coefficient of seed i.e. quintals of output from one quintal of seed.

Assuming Si quantity of quality seed available in a year, quality seed available from crop produce from F_1, F_2 and F_3 generation seed of a variety could be computed as follows:

Quality Seed availability	Crop Production	Proportion of Z used as seed next year
$F_1 : S_1$	S_1*Z	$S_1*Z*P_1 = S_2$
$F_2 : S_2$	S_2*Z	$S_2*Z*P_2 = S_3$
$F_3 : S_3$	S_3*Z	$S_3*Z*P_3 = S_4$

Substituting the values of S_3 and S_2 in terms of S_1, we have quality seed from $F_1 = S_1*Z*P_1$, $F_2 = S_1*Z^2*P_1*P_2$ and $F_3 = S_1*Z^3*P_1*P_2*P_3$. Further assuming S_1 quantity of quality seed produced every year, the quality seed available in the last year of the recommended replacement cycle i.e. 4th year, would be:

$$S_t = S_1 + S_2 + S_3 + S_4$$

$$= S_1 + S_1*Z*P_1 + S_1*Z*P_1*Z*P_2 + S_1*Z*P_1*Z*P_2*Z*P_3$$

$$= S_1 (1 + Z*P_1 + Z^2*P_1*P_2 + Z^3*P_1*P_2*P_3)$$

and seed replacement rate

$$R = (S_t * 100) / (A * K)$$

Now if the certified seed production is variable over the years, the total seed availability in a year would be

$$S_t = S_4 + S_3*Z*P_1 + S_2*Z^2*P_1*P_2 + S_1*Z^3*P_1*P_2*P_3$$

and

$$R = (S_t * 100) / (A * K)$$

Using the improved model which includes lateral distribution of seed the seed replacement rate for wheat and paddy is worked out and presented in the Table 2 below.

Table 2 : Seed Replacement Rates with Lateral Distribution of Crop Produce as Quality Seed for Wheat and Paddy

Year	Quality Seed Available (thousand tonnes)		Seed replacement rates (per cent)	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
<u>Wheat</u>				
1986-87	373.6	522.3	16.3	22.9
1987-88	362.6	598.2	15.7	25.9
1988-89	382.9	519.4	15.9	21.6
<u>Paddy</u>				
1986-87	526.9	1051.7	43.0	85.9
1987-88	568.3	1136.9	48.8	97.7
1988-89	551.9	1269.1	44.0	101.2

Note 1 :

<u>Crop</u>	<u>Scenario</u>	<u>Crop produce as seed (%)</u> F_2	F_3	F_4
Wheat	1	5	2	1
	2	7	3	1
Paddy	1	3	1	0
	2	5	1.5	0.5

2. Seed requirements used in the computations were taken from Table 1 above.

The comparision of seed repalcement rates computed with the two models shows that the improved model gives higher replacement rate for both the crops considered here.

Conclusions

Naturally, the seed repalcement rates are higher in case of improved model because of availability of more quality seed from lateral distribution. Further seed replacement rate is higher because of diffusion of larger proportions of F_2 and F_3 generation seed among fellow farmers. In case of paddy the seed replacement rate is higher because of higher productivity of seed. Hence, the model assumes lower rate of crop retention for seed purpose in case of paddy compared to wheat. This implies that while planning seed production of varieties such factors as productivity of seed and lateral distribution of crop produce of F_2, F_3 and F_4 generations may be given due considerations. In earlier years of release of a variety use of F_2, F_3 and F_4 generation produce as seed may be popularised with proper replacement schedule i.e. every year for F_4 , every alternative year for F_3 and every three years for F_2 generation. This would help in quicker spread of new varieties with limited production of certified seed. In fact, for high productivity seed the use of crop produce as seed may not be advocated beyond F_3 generation.