Agriculture and the artificial transmutation of genes

by

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1. Mutations

The Dutch Scientist, Hugo de Vries, pointed out at the beginning of this century, that mutations or sudden heritable changes constitute the bricks of evolution. All genes in living organisms mutate at different frequencies, thus providing the basis for the enormous diversity seen in the biological world. Most mutations may be harmful but the odd beneficial ones preferentially survive under natural selection. This is how man has evolved from microbes - through selection andgene recombination acting upon blind mutations - a process which has been described by Prof. H.J. Muller as "muddling through". Mutations which may be harmful under one set of conditions may be beneficial in another environment. A good example of this is the frequent occurrence of the gene causing sickle cell anaemia in areas where malaria is endemic. In such regions persons with sickle cell gene are at an advantage, since they are not attacked by malaria.

2. Artificial induction of Mutations

Man acquired the ability to do what nature does for creating new variation, when Prof. H.J. Muller of the United States discovered in 1927 that mutations can be induced by X-rays. This discovery earned him in 1946 the Nobel Prize in Physiology and Medicine. Since then, a wide range of radiations such as gamma rays produced by radio-isotopes and neutrons generated in reactors have become available for treating plants and animals. Also, a wide range of chemicals which produce mutations like radiations and hence known as "radiomimetic chemicals" have been discovered. There is a growing understanding of how to manipulate the genes, without causing other associated undesirable effects.

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3. Mutations and crop improvement

The possibility for the controlled creation of variability has assumed great significance in agriculture. The variety is basic to all advances in food production. Unless there is the right type of plant, advantage cannot be taken of water and fertilizer. There is enormous variability in nature in most crop plants and most of the high yielding crop varieties we cultivate result from an intelligent exploitation of natural variability. But even for this, some of the basic material is provided by naturally occurring mutations. For example, the genetic factors for dwarfing which are responsible for the high yield potential of the Mexican Wheats and Taiwan rice arose as spontaneous mutations in the "Norin" Japanese Wheat and "Dee-gee-woon-geon" Chinese rice. Mutation breeding has hence become an invaluable supplement in the armoury of the plant breeder, particularly for rectifying any defects found in a good variety.

4. Mutations induced at the IARI

Several thousand mutations have been isolated at the IARI in wheat, rice, barley, potato, tomato, chilli, oilseed crops, cotton, jute and ornamental plants. The following varieties have been released for cultivation:

(a) N.P. 836: This is a mutant variety having bristles or awns in the ears, produced by irradiating N.P. 797, a variety without bristles. N.P. 797 is popular in Bihar, eastern U.P. and West Bengal becuase of its rust resistance. Our farmers prefer the bearded wheats becuase of the bird problem. N.P. 836 was released for cultivation in 1960. Bristles have also been put into several other wheats such as Ridley, a popular variety in the lower hills.

(b) Sharbati Sonora: This variety was recently approved for release by the Central Variety Release Committee of the ICAR. It is a mutant produced by gamma treatment of seeds of the Mexican dwarf wheat, Sonora 64. The Mexican strain has red grains, while the mutant has the sharbati grains which fetch the highest price in our grain market.

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Many other mutants in wheat, barley, toria and chilli are meaning the final stages of testing and are likely to be released in a year.

5. Break through in the improvement of quality of food grains

The most urgent need of our country is improvement of the nutritional quality of our food grains. There is widespead protein malnutrition in the country and it is well established now that such malnutrition particularly in the young may cause a permanent impairment of mental and physical faculties. The prospects for meeting this danger soon through increased production and consumption of animal products are not bright. Hence, proposals such as enrichment of wheat kernels with lysine are now being considered. Recent research at the IARI has shown that protein quantity and quality can be improved greatly through induced mutations. Thus, Sharbati Sonora has 25% more protein than the parent Sonora 64. The japonica rice variety Taichung 65, which is giving high yields in Mysore State, has sticky grains and a low amylose content. This has now been corrected by gamma ray treatment and a strain with the high yield of Taichung 65 as well as grains with a high amylose content and non-sticky nature has been developed. This is undergoing trials in Mysore.

It is hoped that soon a variety of Khesari dal which is free of the neurotoxin (B-N-oxalyl amino alanine) which causes the disease lathyrism will become available. Similarly, attempts are in progress to reduce the content of leucine in jowar, which is responsible for the disease pellagra in Andhra Pradesh. It is hoped that within the next two years the high yielding varieties programme will become a high yielding-cum-high quality varieties programme.

6. New genes for tomorrow

A large variety of altogether new characters are being created. For example wheat is being made to produce branching in the ear, like rice or jowar. Different species are being created from a single species of wheat. The era of algeny (this is a term coined by Prof.J.Lederberg to indicate genetic alchemy or transmutation of genes) has thus truly begun.

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Corn proteins / alcohol soluble – Zeins

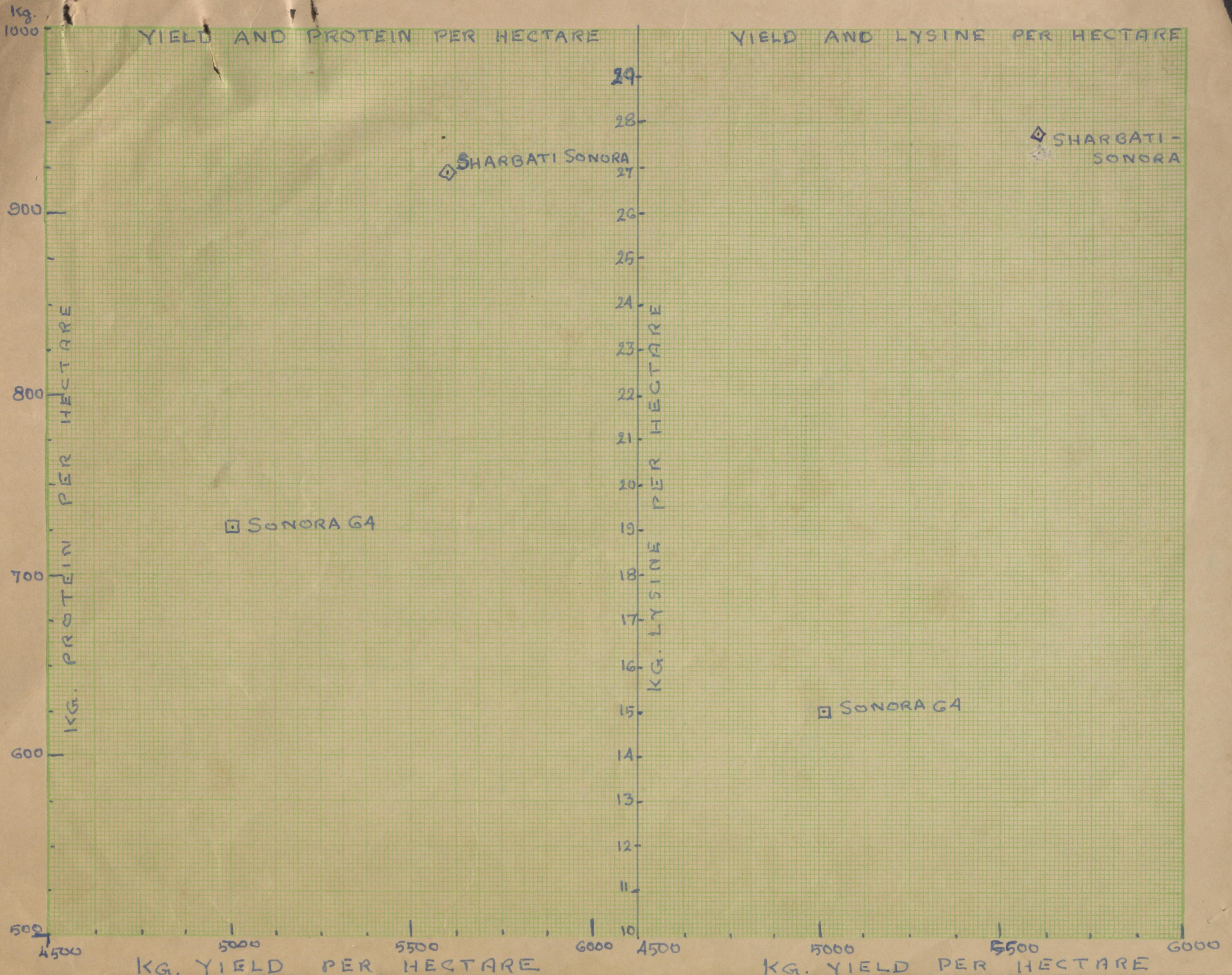
\ acid soluble – glutelin

Nebraska – Wheat analysis

Variation in protein content

9.0 to 24.1

Lysine content 1.77 to 3.87


YIELD AND PROTEIN PER HECTARE
Kg.
KG. PROTEIN PER HECTARE
1000
900
800
700
600
500
SHARBATI SONORA
SONORA 64
4500
5000
5500
6000
KG. YIELD PER HECTARE
YIELD AND LYSINE PER HECTARE
KG. LYSINE PER HECTARE
29
28
27
26
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16
15
14
13
12
11
10
SHARBATI - SONORA
SONORA 64
4500
5000
5500
6000
KG. YIELD PER HECTARE

GRAIN YIELD AND PROTEIN AS INFLUENCED BY NITROGEN FERTILIZATION