GENOME EDITING IN PLANTS

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Agriculture feeds humans

PLANT BREEDING

- GROWING HUMAN POPULATION
- CLIMATE CHANGE AND DISEASES

PLANT BREEDING:

Makes use of **genetics** to change the traits of plants in order to **produce desired characteristics**

CROPS ARE SUBJECTED TO CONTINUOUS BREEDING TO IMPROVE:

- Crops **yield** and **yield stability**
- Resistance to **changing environmental conditions**
- Resistance to **patogens**
- ....

Rice is the main cereal harvested for human consumption

RICE IS THE FOCUS OF EXTENSIVE SCIENTIFIC RESEARCH WORLDWIDE

oryza alta | oryza ridleyi | oryza granulata | basmati 370 | azucena | IR-64 | mafatag | new plant type

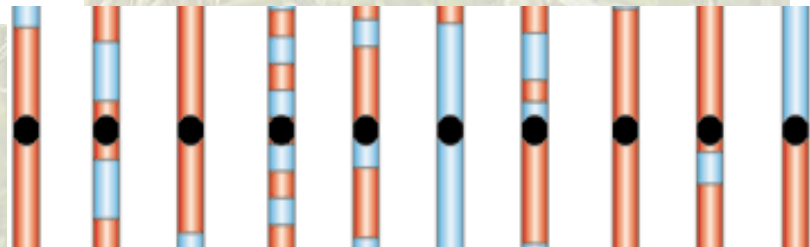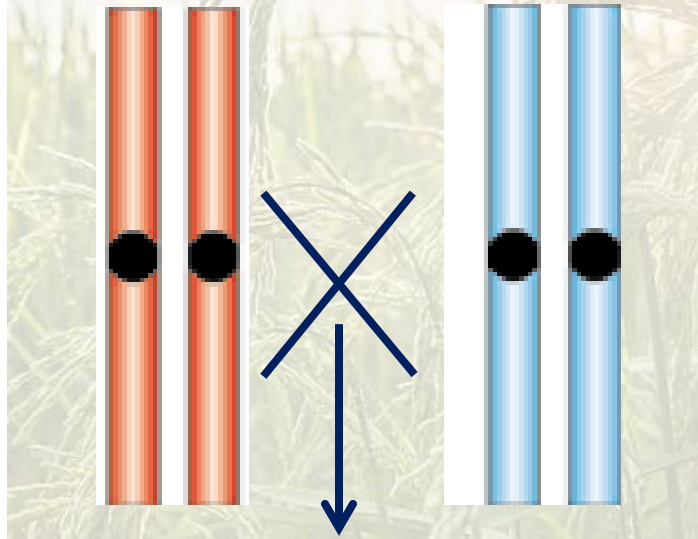# Rice breeding

1) CROSSING

2) RANDOM MUTAGENESIS

3) NEW BREEDING TECHNOLOGIES or
PRECISION BREEDING or *GENOME
EDITING*

1) CROSSING

ELITE VARIETY
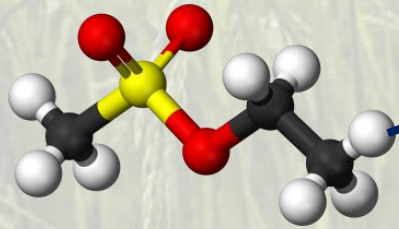
VARIETY WITH A POSITIVE TRAIT

8-10 YEARS

TIME CONSUMING – UNEXPECTED RESULTS
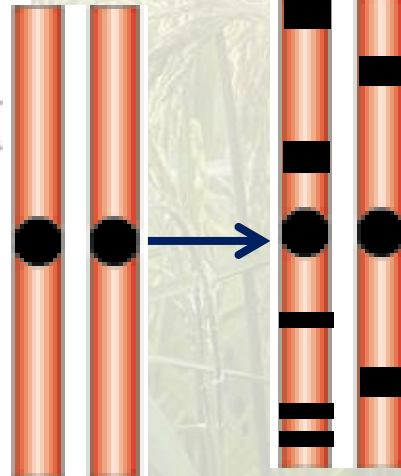
2) RANDOM MUTAGENESIS

γ- rays

ELITE VARIETY

RANDOMLY MUTATED ELITE VARIETY

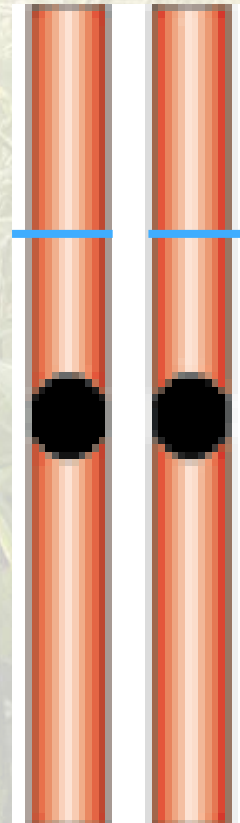Randomly break and mutate the DNA

Chemical compounds

?

TIME CONSUMING - UNEXPECTED RESULTS

3) NEW BREEDING TECHNOLOGIES
or PRECISION BREEDING
or *GENOME EDITING*

IMPROVED VARIETY

- **Technology**

- **Knowledge**

The "ideal breeding"
Fast and precise
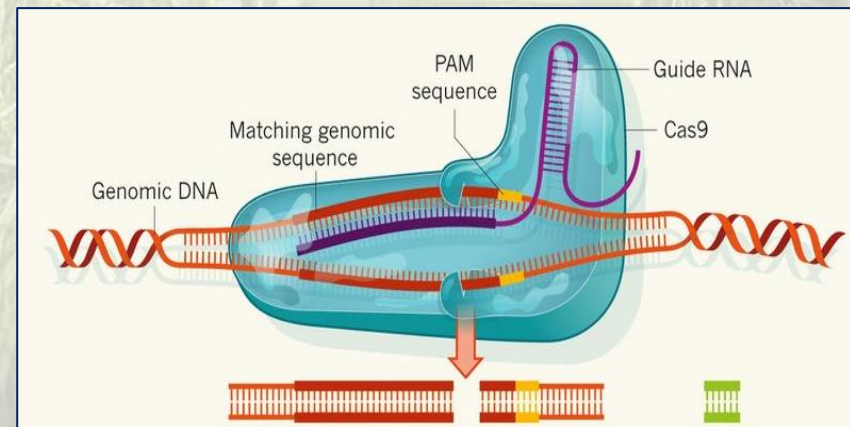
Technology

E.Charpentier   J.Doudna

F.Zhang

INVENTION FROM BASIC RESEARCH IN BACTERIA

CRISPR/CAS9
(and subsequent modifications)

- Easy to use

- Precise

- Versatile

Knowledge

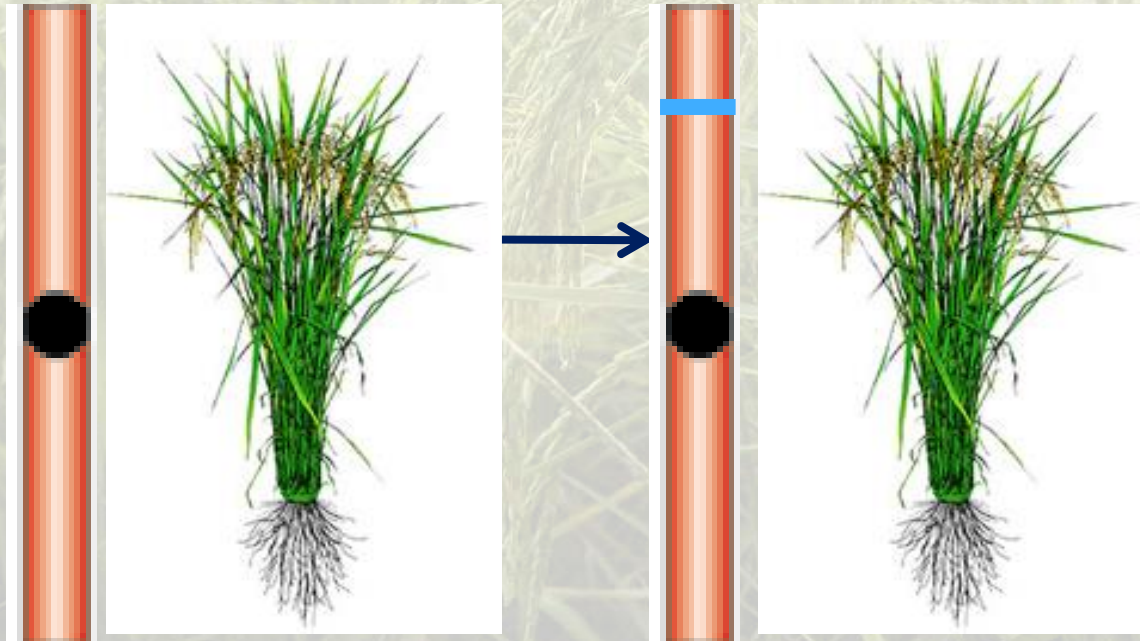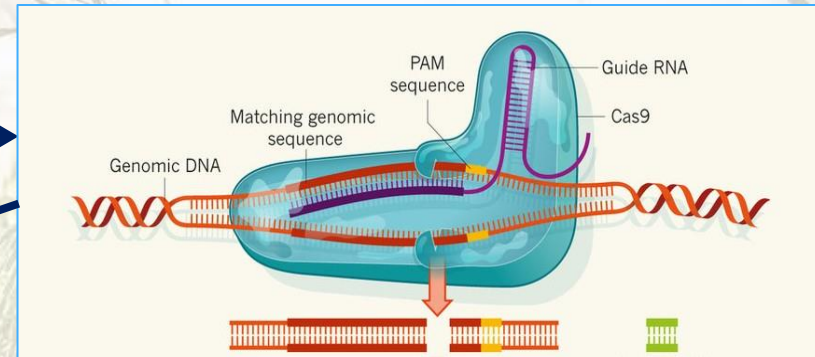- **RESEARCH** IS WORLDWIDE VERY ADVANCED

- WE KNOW THE **MOLECULAR AND GENETIC BASES** OF MANY TRAITS

IRRI

oryza alta oryza ridleyi oryza granulata basmati 370 azucena IR-64 matatag new plant type

GENOME EDITING

RICE FLOWERING

Allows shortening of the cropping season

Important breeding trait for European rice

RICE FLOWERING

WE IDENTIFIED TWO GENES THAT DELAY FLOWERING

WE USED CRISPR TO INACTIVATE THEM

- **FAST: 6 MONTHS**
- **100% Efficiency**: all plants recovered had both genes inactivated
- **Specificity:** no off targets were found

Original plants   Early flowering plants

RICE TRAITS IMPROVED BY CRISPR

GENES	TRAIT	REFERENCE
OsBADH2	Aroma	Shan et al. (2013)
SWEET1a-1b-11-13	Reisistance to *Xantomonas oryzae*	Zhou et al. (2014)
Gn1a, GS3, IPA1	Increased yield	Li et al. (2016)
DEP1	Increased yield	Wang et al., 2017
.....		

EVERY WEEK NEW TRAITS ARE ADDED TO THE LIST!

Genome editing is used to improve several crop species

Mushroom-Yang 2016

Corn-Dupont 2016

Tomato-Nekrasov 2017

Potato-Andresson 2017

Wheat-Liang 2017

Soy - Demorest 2016

"did not detect off-target mutations"

"no off-target mutations are detected in the mutant plants"

Thanks to all the young scientists of the rice lab group at the University of Milan

Fabio Fornara

Martina Cerise

Micol Aldrovandi

Francesca Giaume

Thank you