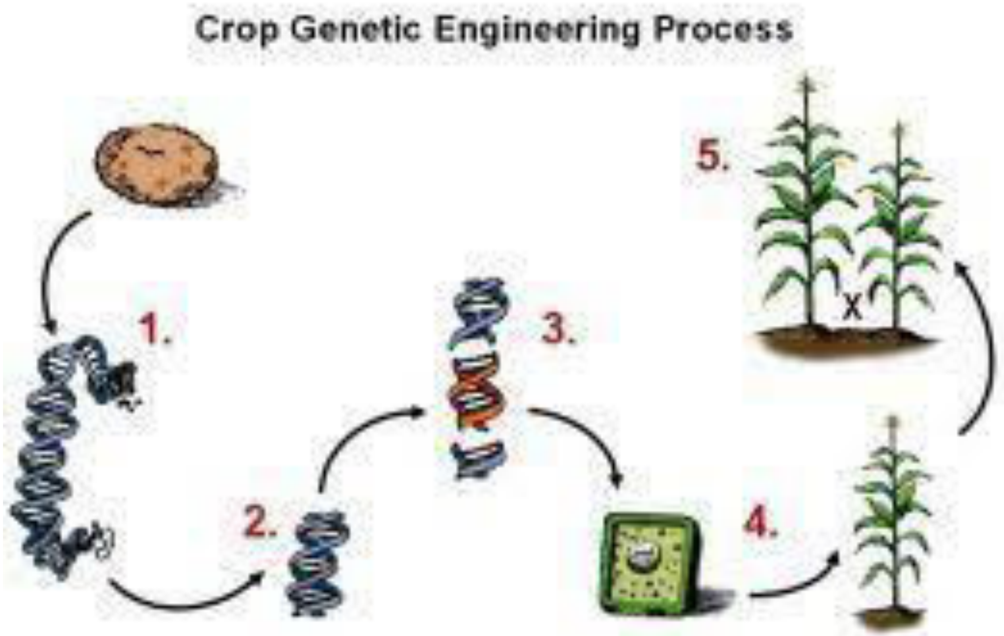
Comprehensive View On Second Generation Transgenic Crop

Course Instructor
Dr. Adesh Kumar
Dept. of PMBGE

Auroshikha Mohanty
Ph.D. Agril. Biotechnology
ID A-12457/21

What are transgenic crops ?

The crops that are genetically modified crops or their gene is manipulated to perform a specific function are known as transgenic crops



Global ranking of major GM producers

Rank	Country	Areas/Million Hectares
1st	USA	66.8
2nd	Brazil	25.4
3rd	Argentina	22.9
4th	India	9.4
5th	Canada	8.8
6th	China	3.5
7th	Paraguay	2.6
8th	South Africa	2.2
9th	Uruguay	1.1
10th	Bolivia	0.8
11th	Philippines	0.5
12th	Australia	0.2
13th	Burkina Faso	0.1
14th	Mexico	0.1

Source: ISAAA, Report, 2010

Benefits to farmers

1) **Considerable reduction in cost of production**

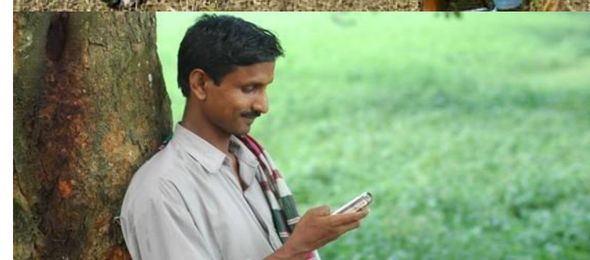
  - saving on cost of insecticides

  - lower labor cost as a result of reduced spraying

2) **Manifold increase in yield per unit area** by saving fruits from damage caused by FSB.

3) **Significant improvement in marketable fruits** thereby increasing income per unit area.

4) **Reduction in direct exposure to insecticides** leading to lesser health problems.



Benefits to ecology and environment

1) **Reduction in pesticide residues in soil and water**

2) **Lesser pollution of air and local environment due to decreased use of insecticides.**

3) **Protection of naturally occurring predators and parasitoids and other beneficial organisms due to reduced use of insecticides.**

4) **Reduction in soil and ground-water contamination.**

5) **Safeguarding soil microflora and invertebrates from damage caused by unintended and excessive use of insecticides.**

Types of GM Crops

1st generation

Traits such as herbicide tolerance, insect resistance and better tolerance to environmental stress.

Examples – herbicide resistant soyabean, insect resistant maize.

2nd generation

Increased level of protein, modified fats, modified carbohydrates, increased flavour or increased micronutrients.

Examples – Rice with high level of beta carotene, tomato with high level of carotenoids.

Golden rice

It was created by Ingo Potrykus. Golden rice is a variety of rice produced through genetic modification to biosynthesis the precuror of beta carotene (Pro vitamin A) in the rice endosperm.

Golden rice was created by incorporating rice with two beta carotene biosynthesis genes:
Phytoene synthase (psy)
Lycopene cyclase

Your Text Here

VitaminA

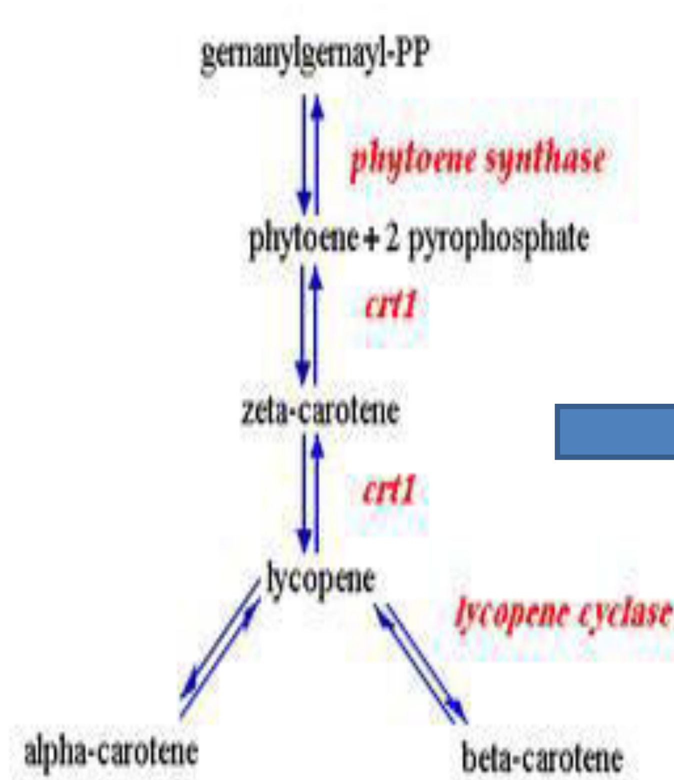
- **ßCarotene, a precursor of vitamin A does not occur naturally in the endosperm of rice .Transgenic rice first produced with engineered pathway for ß-carotene was yellow in colour and was given name as Golden rice.**
- **Biochemical analysis confirmed that the yellow color of grain represented ß-carotene (provitaminA).The level of ß carotene in 1gram of transformed rice was 1.6µg, which is sufficient to provide 15-20% of daily need for vitamin A.**

Target group	Iron deficiency	Zinc deficiency	Vitamin A deficiency
Children	• Impaired physical ability • Impaired mental development • Child mortality (related to maternal deaths)	• Diarrhea • Pneumonia • Stunting • Child mortality	• Child mortality • Measles • Night blindness • Corneal scarring • Blindness
Women	• Impaired physical • Maternal mortality		• Night blindness in pregnant and lactating women

β-Carotene (Pro-Vitamin A) Rice

(Golden Rice)

Dr Ingo Potrykus
Dr Peter Beyer



<u>Psy–Daffodil/Maize</u>
<u>Crt1–Erwinia</u>

Golden Rice:History (before 2000 and up to 2005)

Prototype GR in 2000 | GR1 -2004 | GR1 -2005

1.2 – 1.8 | up to 8.0 | up to 36.7

Provitamin A Carotenoid levels (ug/g)

Iron Content and Bioavailability

•**One of the major challenges with iron is that its mobility in the rhizosphere is dependent on the soil conditions, because only the ferrous form(Fe_2) is soluble and bio available to plants whereas the ferric form(Fe_3) is sequestered into insoluble complexes with soil particles.**

•**Plants have evolved two counter strategies, one of which is to secrete reductases into the soil to convert ferric iron into the soluble ferrous form, and the other is to release chelating agents known as phytosiderophores(PS) that can be reabsorbed by the roots as PS-Fe3+ complexes.**

•**Iron levels in plants can therefore, be improved by increasing the export of both reductases and phytosiderophores, for instance, by overexpressing the enzymes Nicotianamine Synthase(NAS) and/or NicotianamineAminotransferase*(NAAT), which are involved in phytosiderophore synthesis.***

•**Transgenic rice plants expressing the *NAS genes Osnas1,Osnas2orOsnas3 accumulated upto19µg/g of iron in the endosperm***

Plant Ferritin

•Ferritin is an unique iron storage molecule. Iron is stored in inner cavity of Ferritin as Fe_3-hydroxy-phosphate.

•There was increase of iron content in rice plants with the expression of ferritin gene from *Phaseolus vulgaris,which will bind iron and st ore it in non toxic form.*

Phytase gene

• To decrease pytin content, we increase phytase level, which is crucial in the absorption of Iron

• Iron bioavailability has been increased through the introduction of phytase gene from *Aspergillus fumigatus in endosperm.*

• Transformed rice showed increased phytase level upto 130-fold, giving phytase activity sufficient to completely degrade phytic acid.

•The nutritionally rich rice with more iron content and better phytase activity has great potential for improving iron requirement in developing countries.

Zn Biofortification in Rice

•Zinc in the phloem is coupled with nicotianamine(NA), which is the predominant ligand in rice phloem sap.

•The ZIP family transporter genes of *OsZIP4,OsZIP5,and OsZIP8 are involved in root to shoot Zn transport. OsZIP3 is also involved for the unloading Zn from the xylem of enlarged vascular bundle and regulates the distribution of Zn to the developing tissues*

•Large amounts of grain micronutrients may remain in the outer aleurone layers of the grain and the reasons why this Zn is not loaded into the endosperm are not well understood.

•If the major target is biofortification, the mechanism(s) that determine the allocation of Zn between the aleurone layer and inner endosperm need to be resolved.

•Through genetic engineering method, 3 genes of OsNAS family have been transferred into japonica rice cultivar Nipponbare. Specific expression of OsNAS resulted in significant increse in nicotianamide concentration and Zn.

Resveratrol, a plant phenolic compound, is found in grapes and red wine, but is not widely distributed in other common food sources.

The pathway for resveratrol biosynthesis is well characterized. Metabolic engineering of this compound has been achieved in tomato plants (Lycopersicon esculentum Mill.) in order to improve their nutritional value.

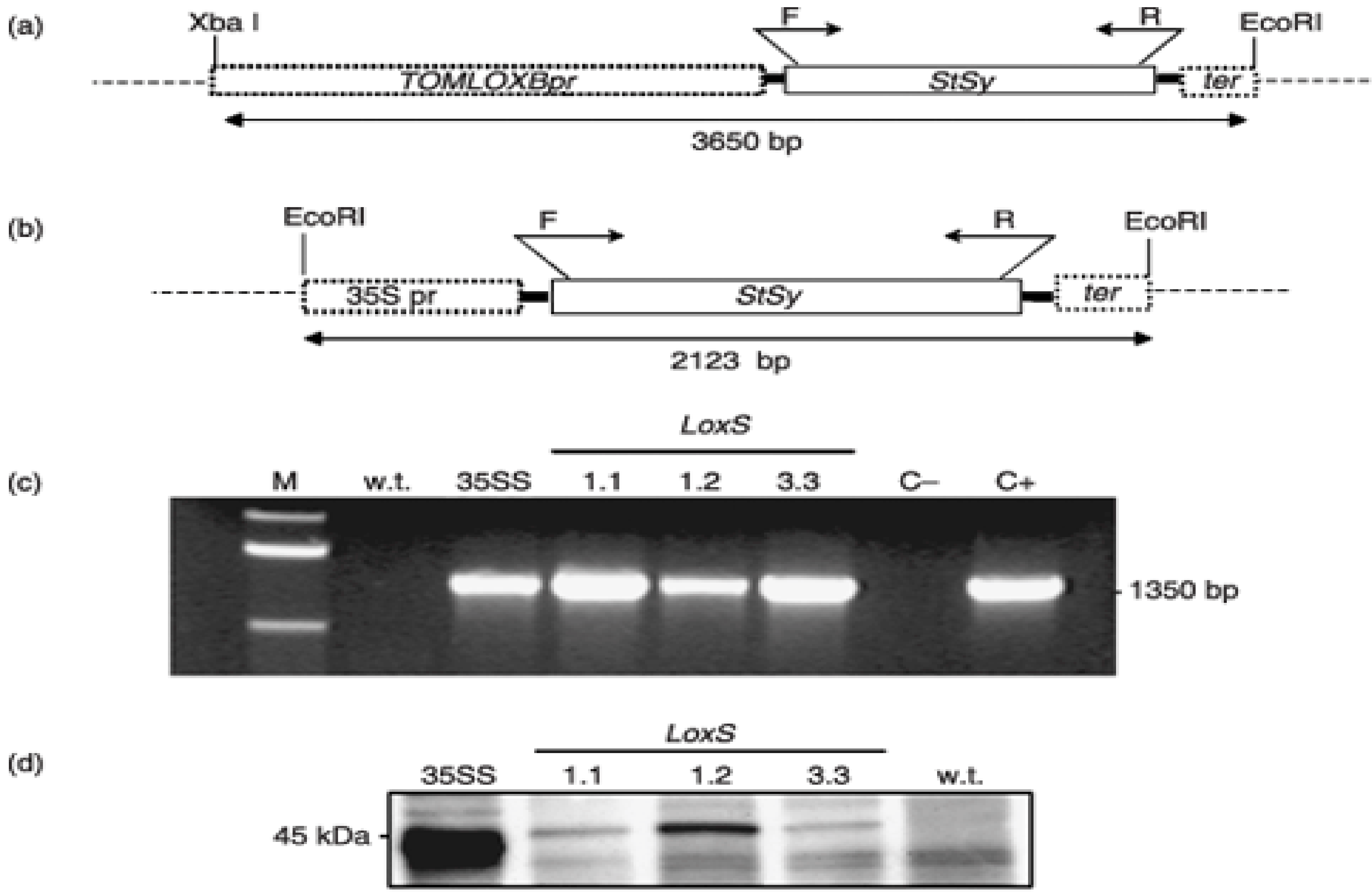
Tomato plants synthesizing resveratrol were obtained via the heterologous expression of a grape (*Vitis vinifera* L.) cDNA encoding for the enzyme stilbene synthase (StSy), under the control of the fruit-specific promoter TomLoxB.

The resulting LoxS transgenic plants accumulated *trans*-resveratrol and *trans*-piceid, in particular in the skin of the mature fruits.

Quantitative analyses carried out on LoxS fruits were compared with those of a tomato line constitutively expressing the *stsy* gene (35SS).

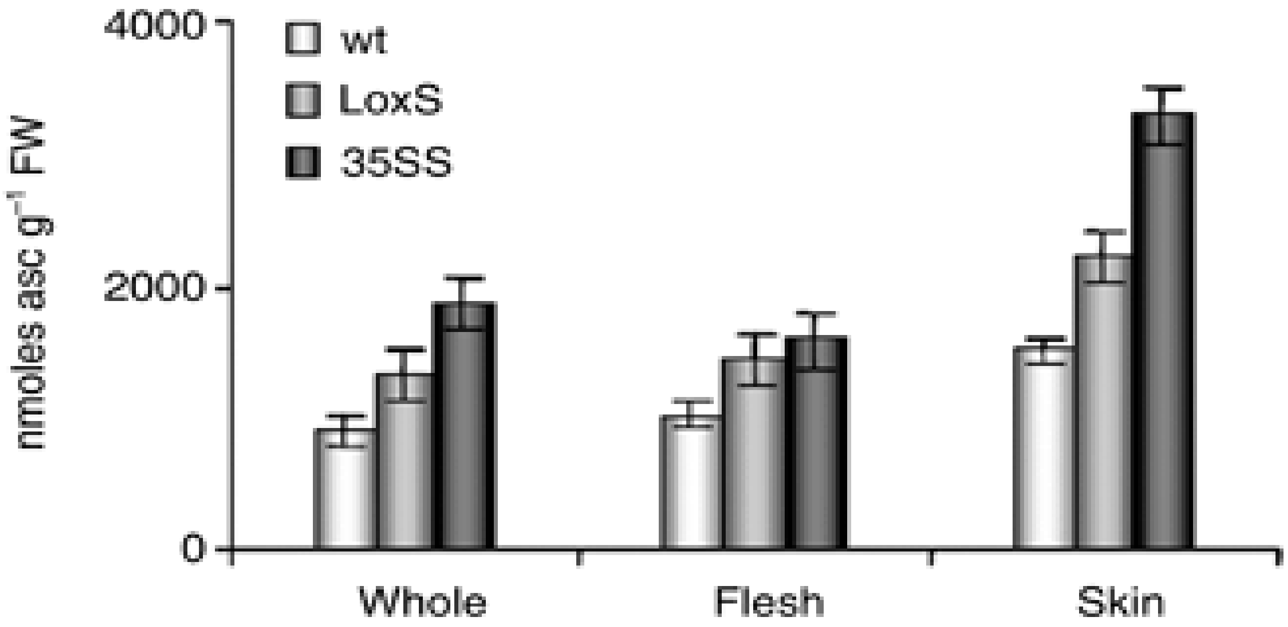
The LoxS fruits contained levels of *trans*-resveratrol that were 20-fold lower than those previously reported for the 35SS line. The total antioxidant capability and ascorbate content in transformed fruits were also evaluated, and a significant increase in both was found in the LoxS and 35SS lines.

.



(a)
Xba I
F
R
EcoRI
TOMLOXBpr
StSy
ter
3650 bp
(b)
EcoRI
F
R
EcoRI
35S pr
StSy
ter
2123 bp
(c)
LoxS
M
w.t.
35SS
1.1
1.2
3.3
C–
C+
1350 bp
(d)
LoxS
35SS
1.1
1.2
3.3
w.t.
45 kDa

Ascorbate levels and total antioxidant capability



Comparison of ascorbate levels (nmoles per gram of fresh weight) in whole red fruit, flesh and skin of wild-type (wt) and transgenic (LoxS and 35SS) mature fruits. Results are averages from three independent experiments. FW, fresh weight; wt, wild-type.

Thank you