

Emerging Technologies and New Product Concepts

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Outline

- What are Emerging Technologies and why do we need to use novel approaches.
- Some areas where Emerging Technologies are likely to yield first results.



Strategies for Introducing a Trait into a Plant Through Biotechnology

1. Introduce all necessary function into the plant
 - Glyphosate Tolerance – CP4 epsps
 - Insect Resistance – Bt proteins
2. Alter plant gene expression so the plant itself provides the necessary function
 - Express a new complement of genes in a tissue
 - Shut down genes that are normally expressed



Emerging Technologies

- **Why?**
- **RNAi: RNA interference**
- **Trancription factors – proteins regulating gene expression**

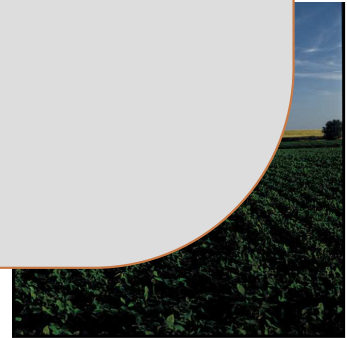
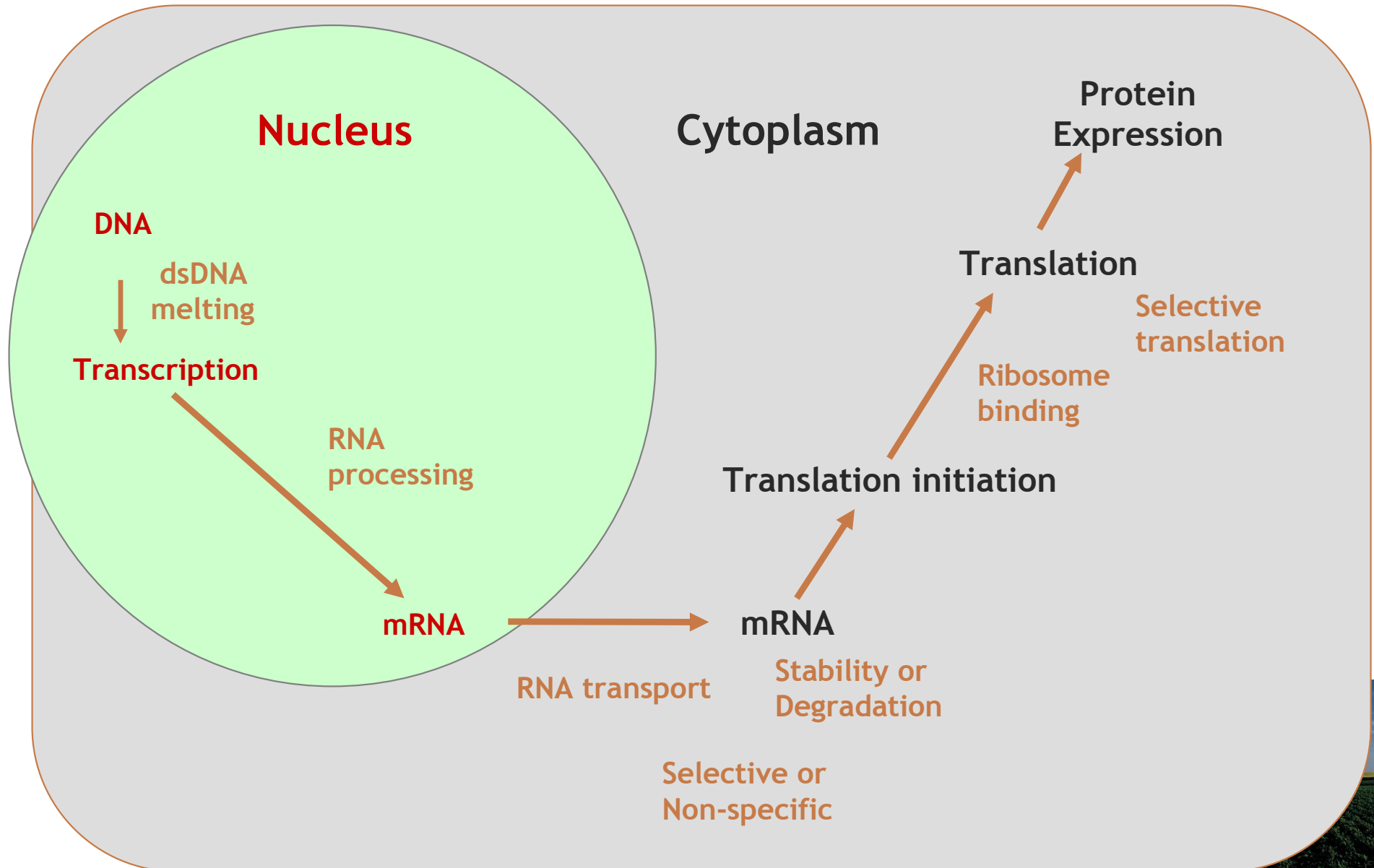


Why may it be desirable to change plant gene expression?

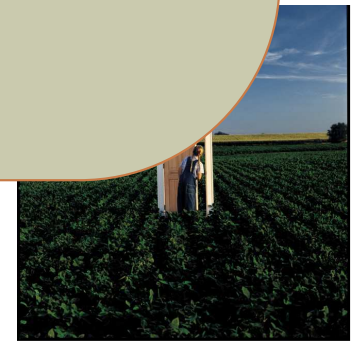
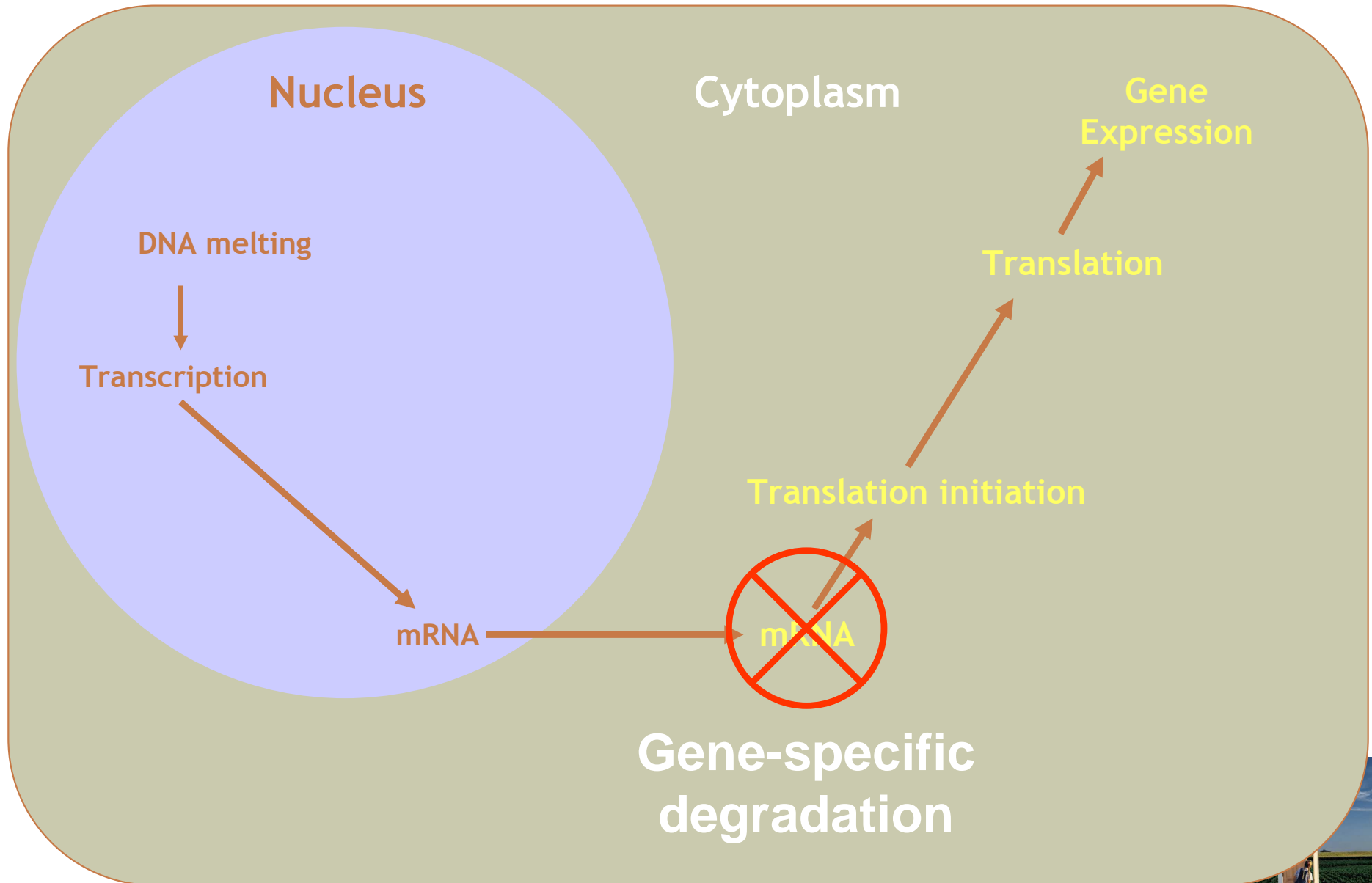
- 1. Quantitative Traits** – Yield, tolerance to environmental stress
 - Traits are generally complex
 - Require the interactions of multiple genes to get a phenotype
- 2. Food Quality Traits** – Improved nutritional qualities
 - Traits involve complex metabolic pathways
 - Knock out key intermediates result in desired outcomes



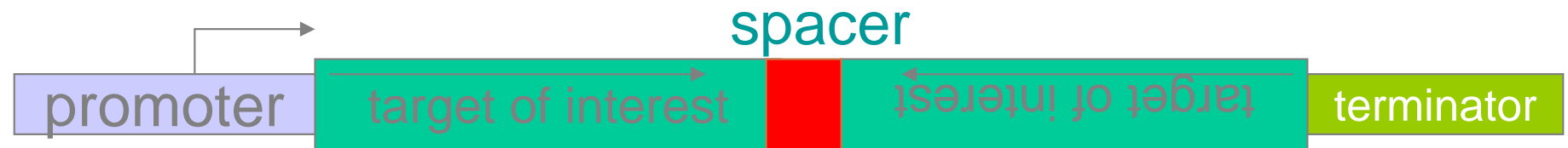
There are multiple ways to regulate gene expression in a cell



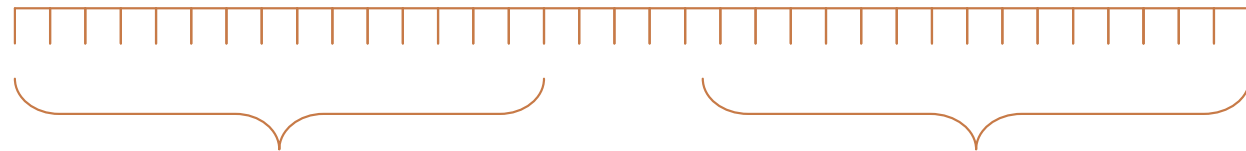
RNAi Selectively Degrades mRNA



RNAi Technology (Mechanism)

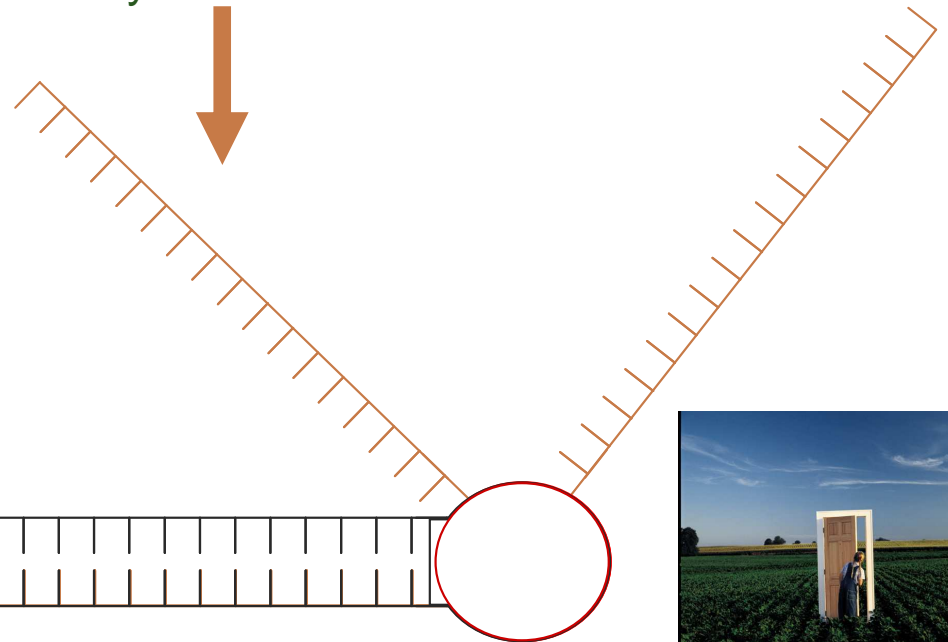


single-strand
RNA transcript



The first half and the second half
are complementary to each other

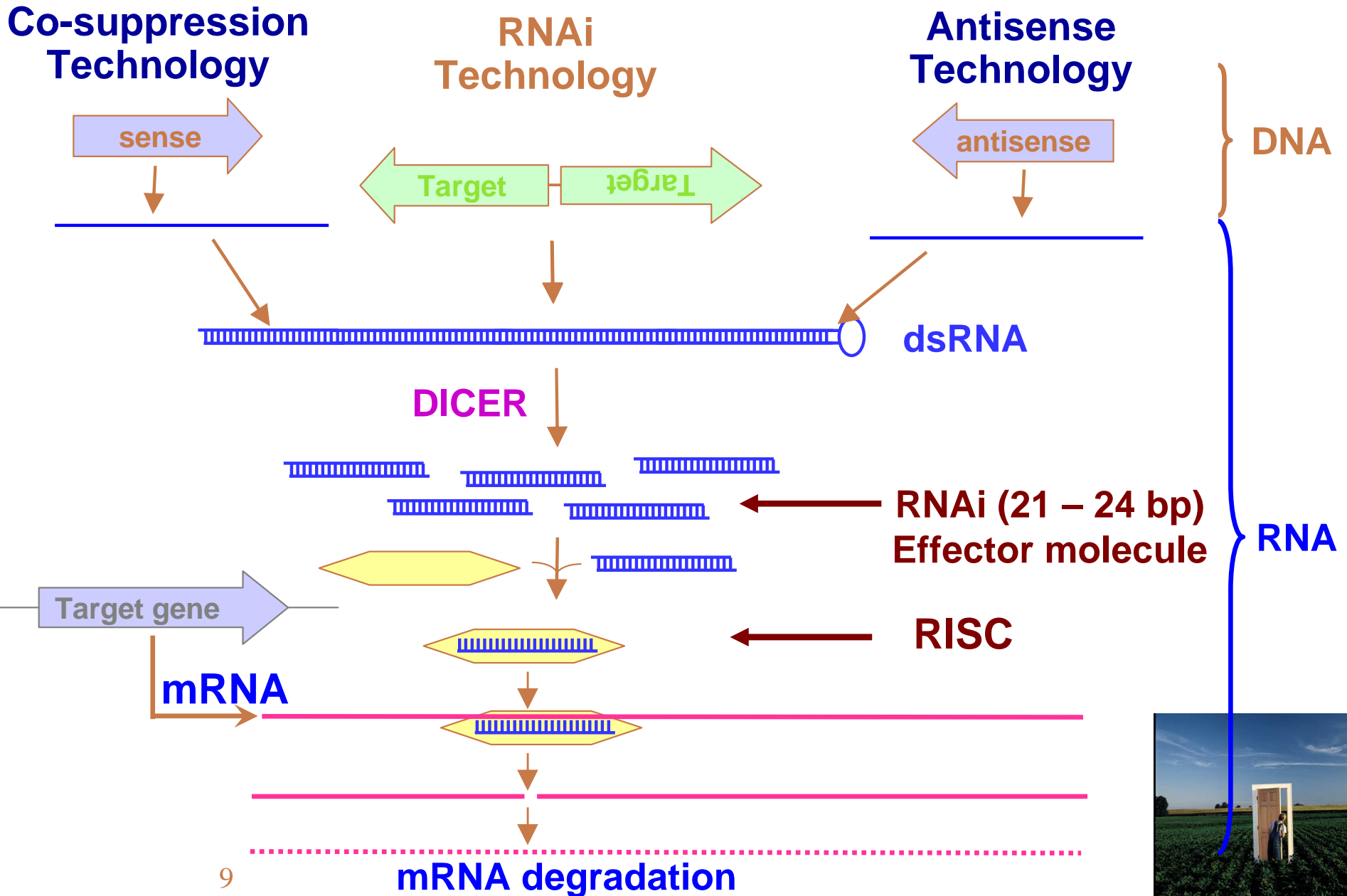
Complementary RNA can “fold back”
on itself and make RNAi



RNAi

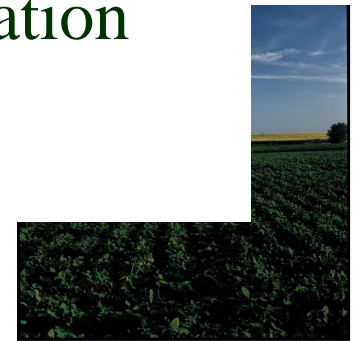


RNAi Acts in a Sequence-Specific Manner To Induce mRNA Degradation



RNA Interference (RNAi)

- New to **science**, ancient to **nature**
- Common mechanism found in plants, nematodes, insects and animals
- Suppresses gene expression by either:
 - Decreasing mRNA abundance directly (degradation)
 - Interfering with protein translation
- Endogenous RNAi cell functions:
 - Down-regulation of exogenous genes (e.g. viral RNA)
 - Down-regulation of endogenous genes (e.g. TxF mRNA)
 - Regulates chromatin structure via DNA methylation and histone modifications



Transcription Factors (TxF)

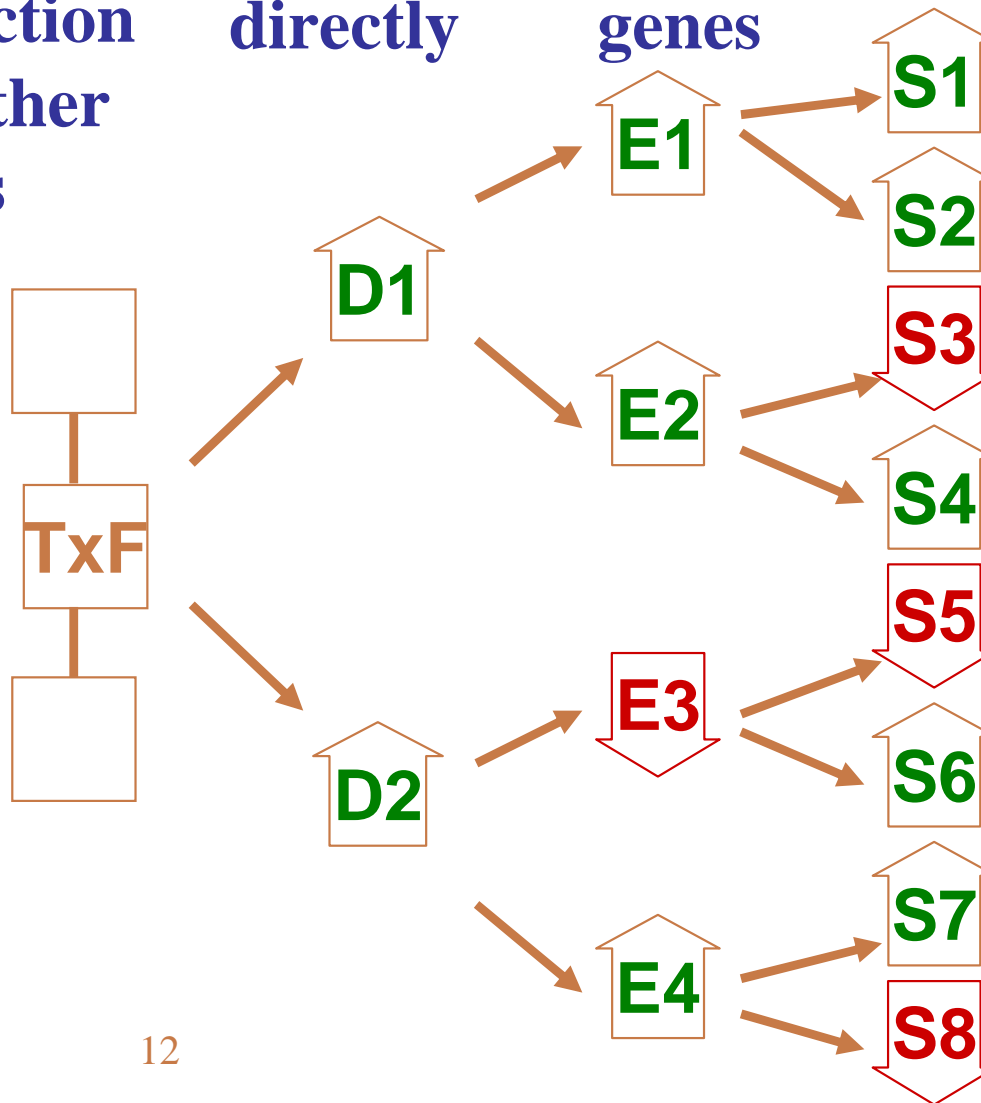
- Regulatory proteins in the nucleus that recognize specific DNA motives in a gene promoter.
- They do not have metabolic or structural functions.
- Can affect the downstream expression of several genes.
- Can only affect the expression of genes intrinsic to the plant in question.



How TxFs Affect Gene Expression

Genes regulated directly Early response genes Secondary genes

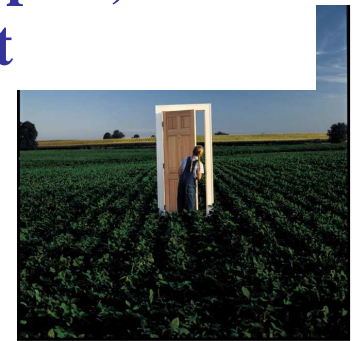
Interaction with other factors



TxFs do NOT have intrinsic metabolic activity

TxFs can only regulate genes already in the cell (no new functions)

A TxF has the capacity of inducing a complex, multigenic trait



TxF Modification Can Affect Fewer Genes Than Breeding

Transcript profiling comparisons between:

- **Inbreds**
- **TxF-based products and nontransgenics**

Inbreds	> 2 fold differences
Breeding event 1	3380
Breeding event 2	1548
TxF#1 vs conventional	23



Summary of Transcription Factors

- TxFs do not carry a trait by themselves
- TxFs can only induce genes already available in the crop
- Modifying TxF expression appears to affect fewer genes than conventional breeding
- TxF is a major contributor to quantitative trait selection by traditional breeding





➤ **Tremendous Potential For Development Of New Products**



Some Areas Most Likely To Benefit From New Technologies

Food and Feed Quality Traits

Improved Agronomic Traits



Food and Feed Quality Traits

- **Lipid enhancements**
 - Increased oil
 - Improved fatty acid balance
- **Protein enhancements**
 - Increased protein content
 - Improved amino acid balance
- **Carbohydrate enhancements**
- **Bioactive compounds – Health benefits**



Improved Agronomic Characteristics

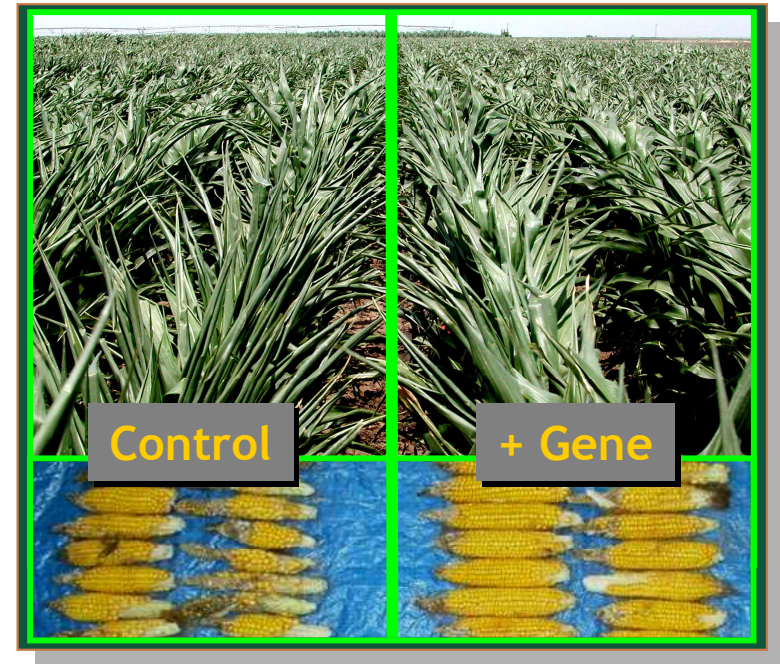
- **Tolerance to environmental stress**
 - Drought
 - Cold
 - High salt
- **Improved nitrogen utilization efficiency**
- **Yield**



Tolerance to low nitrogen



Drought tolerant maize



**Emerging Technologies in combination
with existing traits will provide
additional consumer and farmer
benefits and will make a substantial
contribution to a more sustainable
agriculture.**

Thank you!

