# Technology Transfer & Diffusion: Simple to Talk About, Not So Easy to Implement

**M. Asaduzzaman**

**Bangladesh Institute of Development Studies**

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# Technology Issues in CC Talks

- Of the 4 Bali elements of mitigation, adaptation, finance and technology, negotiations related to technology are at the most advanced stage of actually putting in place an international architecture
- However, this relates to the mechanism of the transfer and development of technology, not how diffusion of technology takes place within a country
- This is the Achilles' heel of the whole issue of CC related technology transfer when a specific technology is made available to a country
- In fact the problems of adoption and diffusion of a new technology is not unique to CC related issues, but is a generic one known to engineers, scientists, economists and sociologists for long

# Technology Transfer in Agriculture

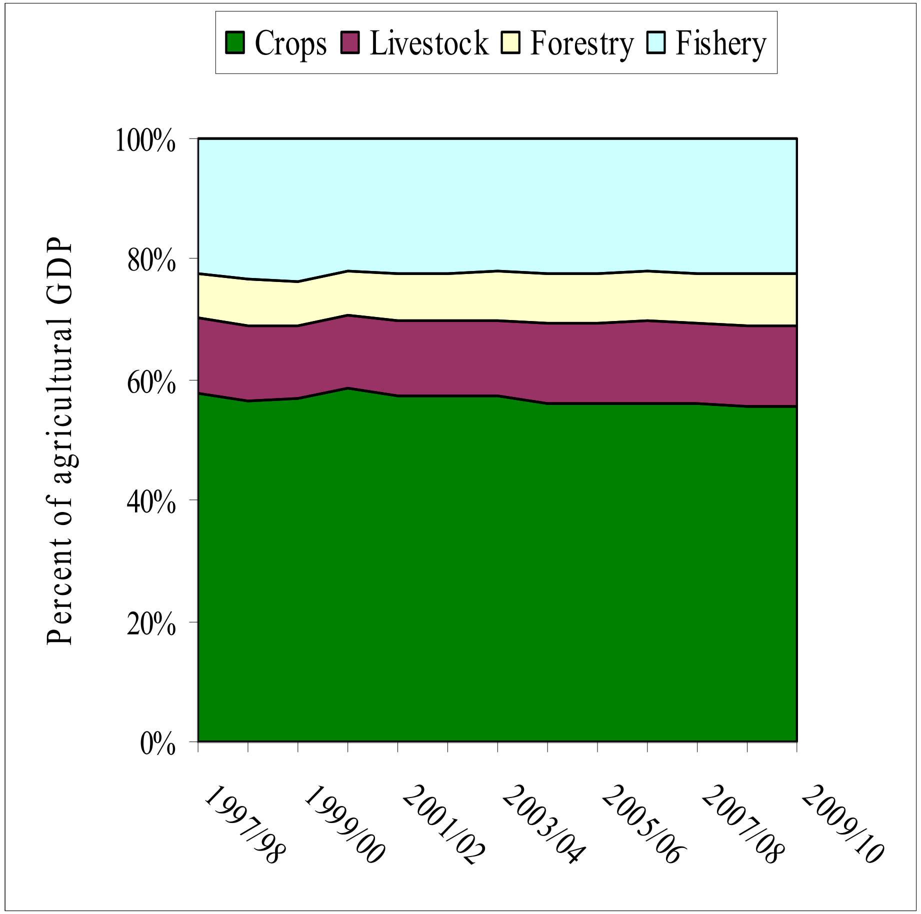
- Technology transfer in agriculture in relation to CC is particularly problematic because of issues of
  - Food security
  - Intertwining of adaptation & mitigation
  - Numerous farmers one has to deal with (in cases millions) rather than a few industries or public bodies making its management a complex issues who are wary of change from a known practice
  - Contradictory policies
  - Conflicts of interest with powerful lobbies

# Present Case Study

- Bangladesh agriculture
- A simple technology in question - Leaf Colour Chart - to optimise use of nitrogenous fertiliser particularly urea
- Optimisation of use of N fertiliser helps in lowering $N_2O$ emission as urea use is excessive for historical reasons as will be discussed later

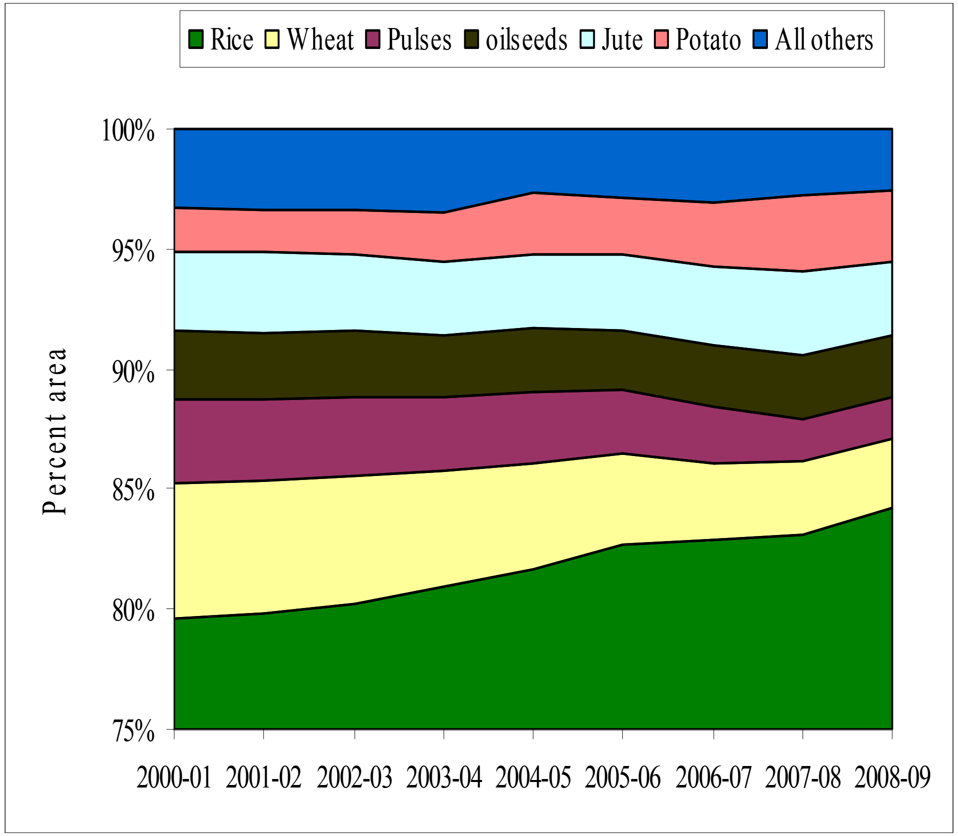
# Some Relevant Basic Facts on Bangladesh Agriculture

- Agriculture presently ~ 20-21% of GDP
- Crop ~ slightly more than 50% of ag GDP
- Rice ~ 64-65% of crop GDP but provides staple and almost self-sufficient



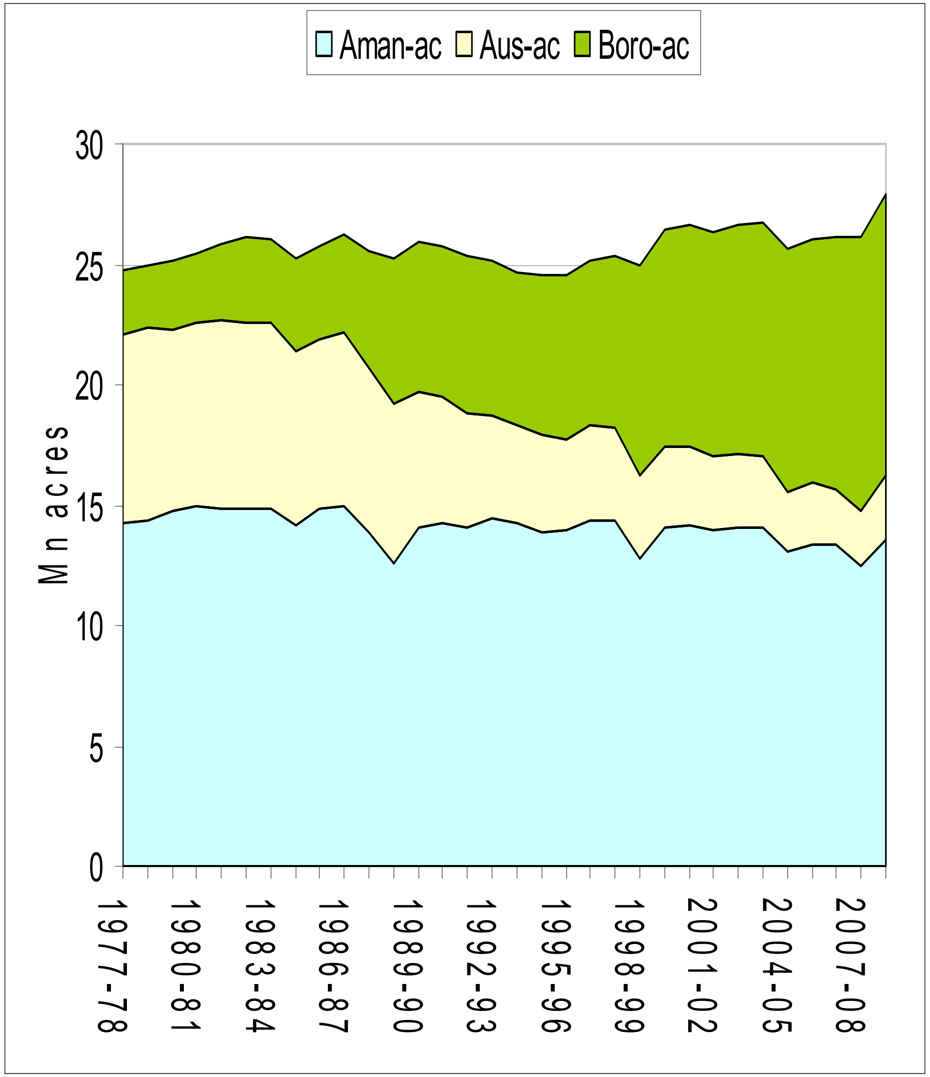
# Predominance of Rice

**Rice dominates all other crops in terms of area; the concentration is in fact rising over time**



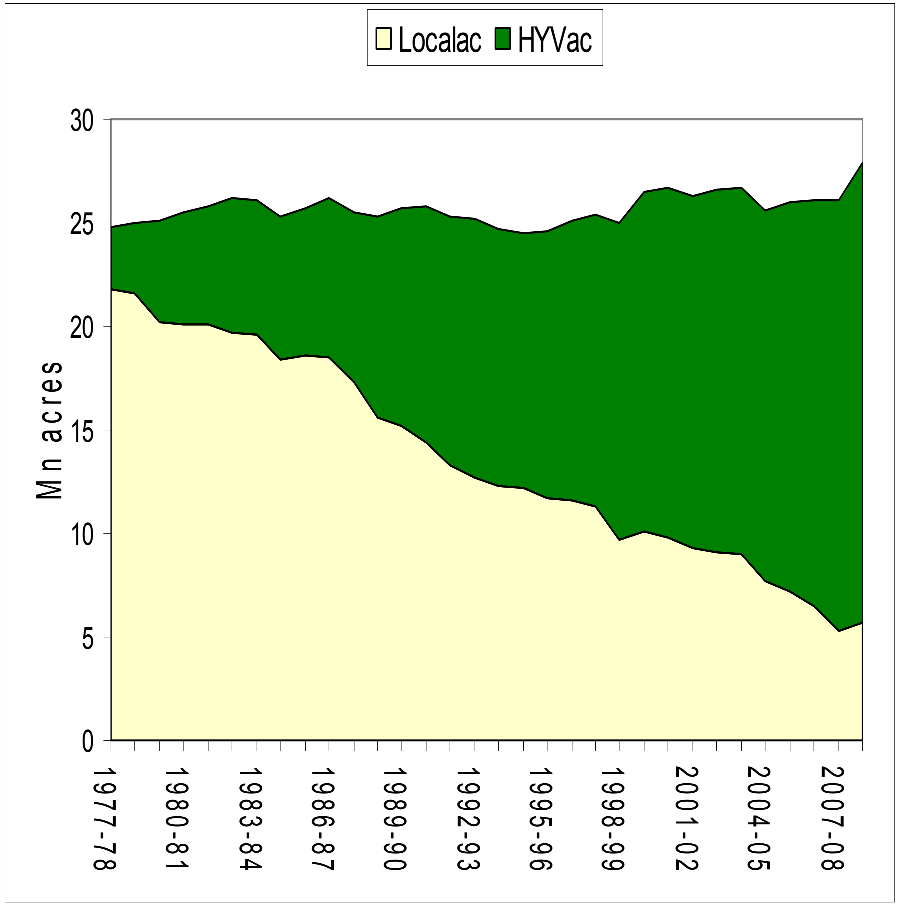
# Characteristics of Rice Culture 1

- **3 seasons – aus, rainfed; aman, mainly rainfed; boro, dry period, wholly irrigated**
- **Boro almost wholly HYV & fertiliser, water mgmt & photoperiod sensitive**
- **Aman area static but prone to natural hazards**



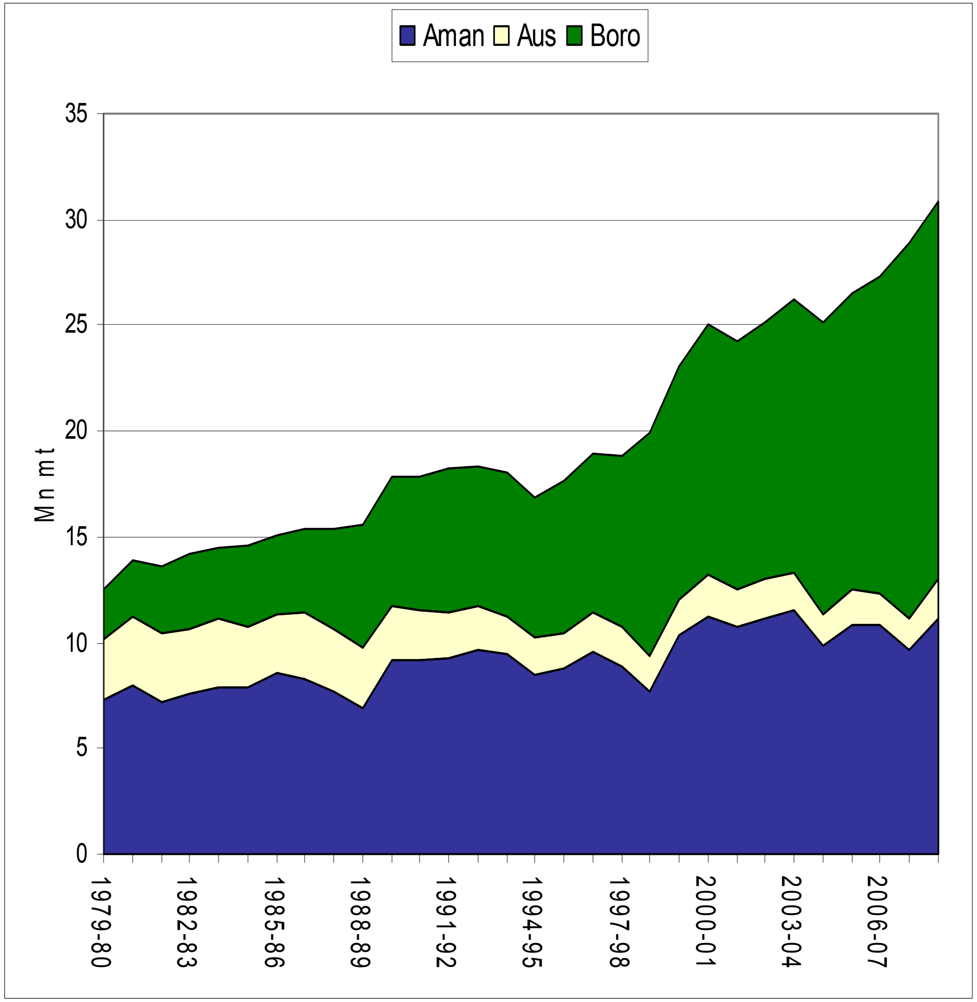
# Characteristics of Rice Culture 2

- Over time HYVs have almost replaced local varieties
- HYVs are sensitive to water management and fertiliser application



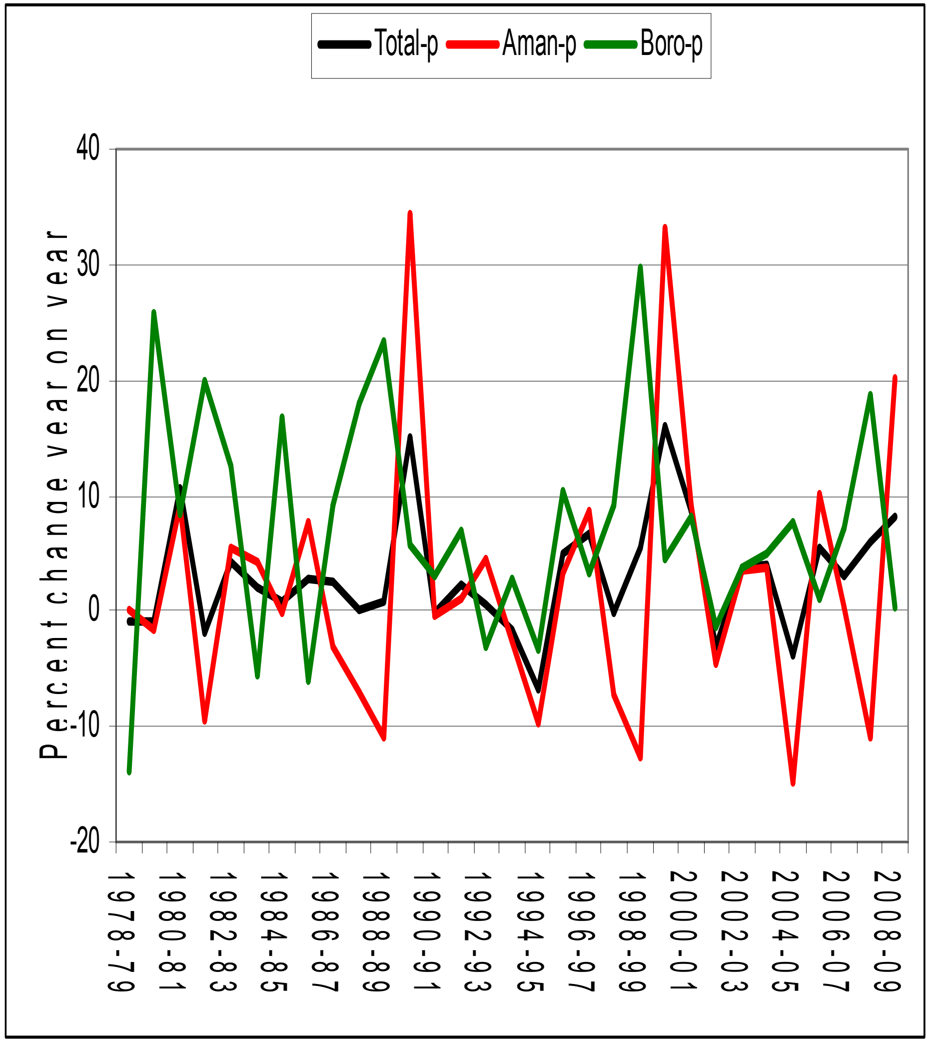
# Characteristics of Rice Culture 3

- **Irrigated boro is mainstay of food security in the country - accounts for ~ 60% domestic rice output**
- **Rainfed aman output has risen slowly**
- **Output of hazard-prone aus has fallen**



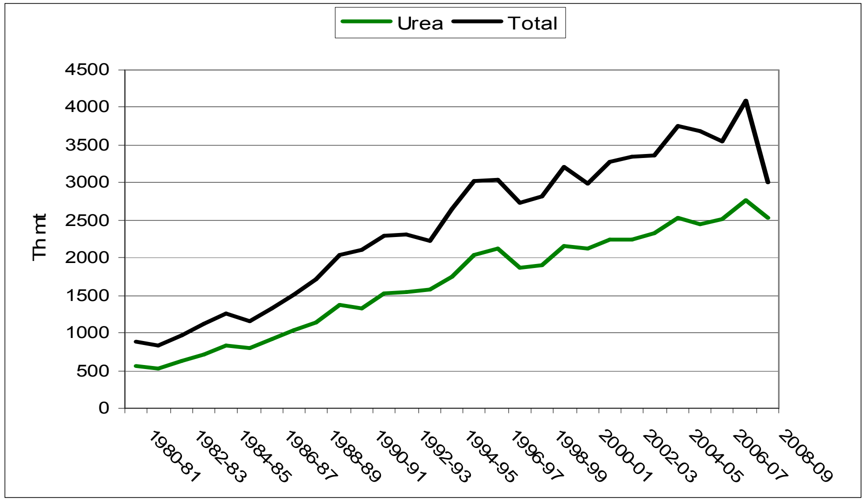
# Characteristics of Rice Culture 4

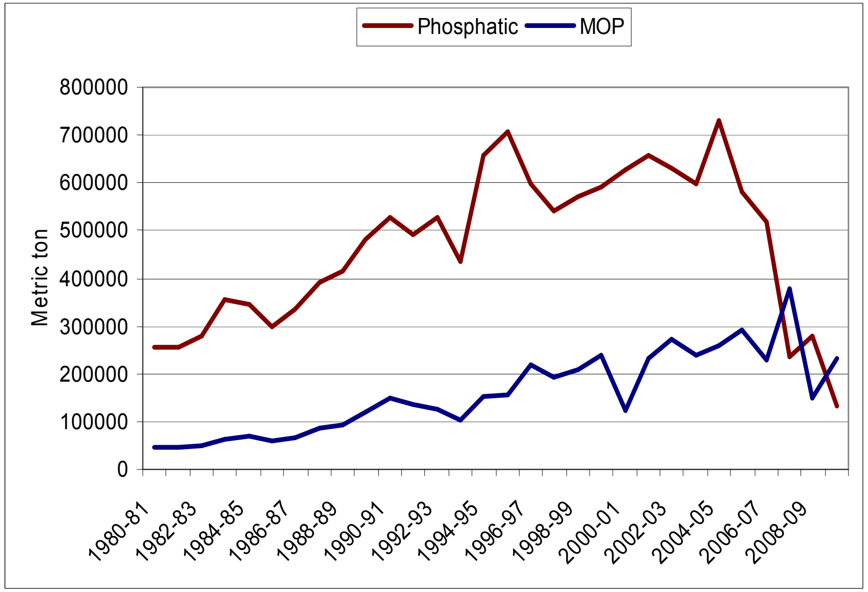
- **Highly variable output from year to year**
- **No wonder farmers wherever possible switch to irrigated boro to ensure food output**
- **But also costly as most intensive in terms water mgmt, fertiliser, pesticides**



# Fertiliser Use in BD Agriculture

- Urea had a fast growth, had been subsidised during much of this period
- So did TSP but it faltered in 2007-09 due to very high int'l prices; in 2009 heavy subsidy was provided



# Rice, Fertiliser and Irrigation

- Rice accounted for 82% of urea consumption in 2008; for TSP and MoP the percentages were 77 & 75
- Of total irrigated area, rice accounted for 85%
- Of the irrigated area, almost entirely due to mechanised irrigation with diesel or electricity
- Small farms (with up to at most 1 ha) account for more than 50% of urea usage and area irrigated

# Implications for Climate Change Mitigation

- Changes in BD agriculture in general, rice cultivation in particular, has implications for GHG emission
- Production, milling, transport of rice are all more energy intensive than before, directly and indirectly – lead to higher $CO_2$ emission than before
- Flooded rice culture emits methane
- Urea use emits $N_2O$
- In general lowering use of any without changing cultural practices will lead to fall in output jeopardising food security – small farmers are likely to be more adversely affected

# Implications for Climate Change Adaptation

- On the other hand, there will be major adaptation needs in agriculture due to much more uncertain weather, severe drought and heavy rainfall as well as changes in their temporal and spatial patterns in addition to rise in temperature and heat stresses. Output variability is likely to intensify. These call for more irrigation in case of drought, changes in cropping schedules and water management as well as fertilser use practices. These may raise rather than lower GHG emission

# Way Out

- **Scientists' view**
  - Cultural practices can be changed and inputs lowered without lowering output
  - Farmers use excessive water and excessive fertiliser – so scope already exists
  - Thus, conflicts between adaptation and mitigation can be minimised without negative effect on food security
- **Proposed agronomic practices**
  - AWD to lower water use & limit methane emission
  - Biofertiliser (cyanobacteria or blue-green algae, azolla) – intercropping with legumes to lower urea use
  - Leaf colour chart (LCC) for optimising use of nitrogenous fertiliser
  - Biofertiliser and LCC lower nitrous oxide emission

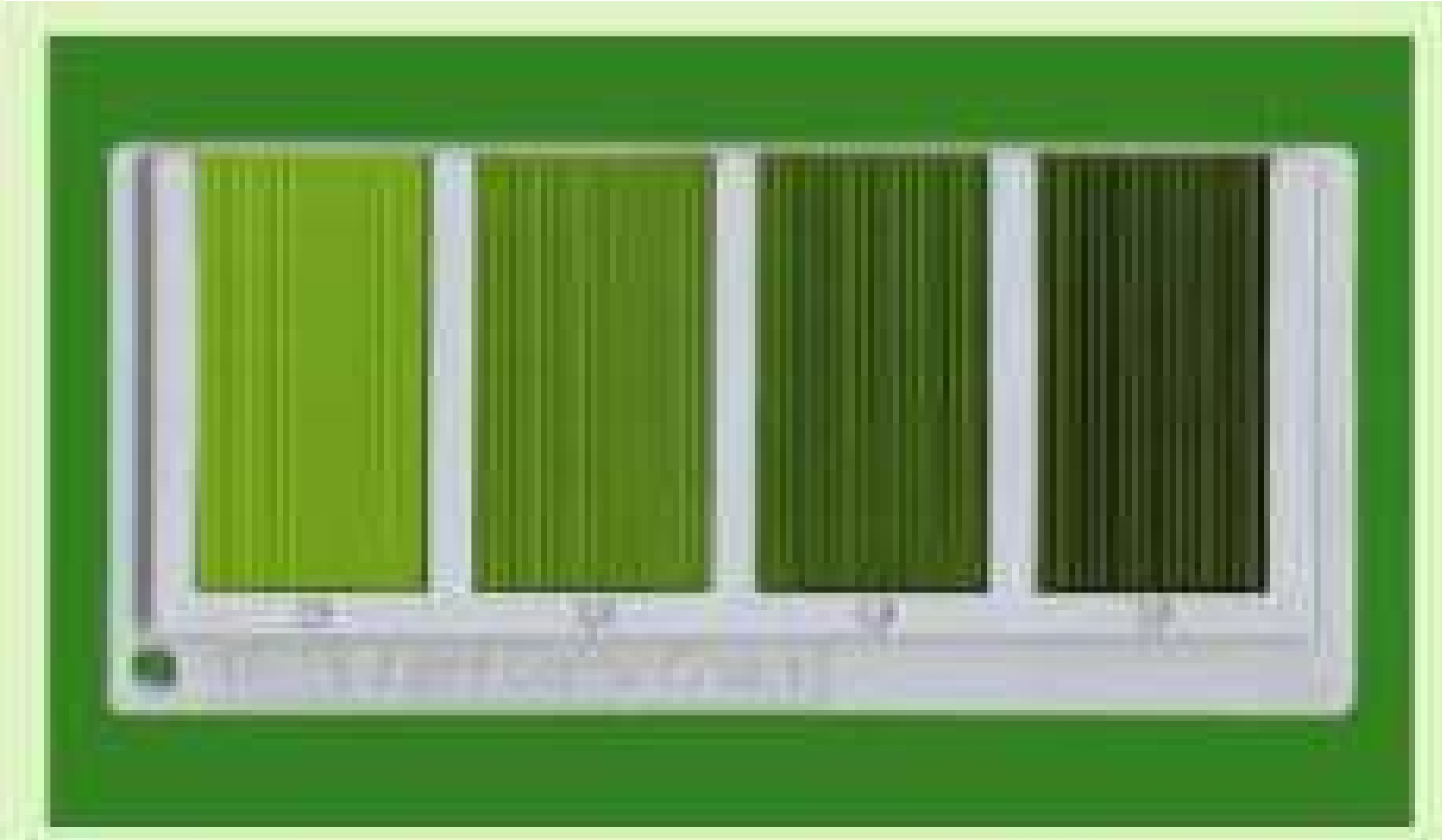
# Scientific Discovery and Lag in Their Use

- These scientific facts had been known for quite some time yet they had either been not in use, or used only on a limited scale
- Leaf colour chart is probably the simplest and had been advocated at least for the last 30 years
- Deep placement of urea pellets also can cut urea usage substantially – adopted only on a limited scale
- Cyanobacteria's beneficial role in rice cultivation has been discovered in Bengal in 1939 – a lot of related research has been done in Bangladesh over last 30 years, but not yet adopted as part of policy for extension
- AWD has only recently been touted and only time will tell if this will be adopted in any major scale
- Major barriers exist in each case - we use LCC as a case study of technology transfer and diffusion

# What is an LCC?

- An LCC is a sheet of plastic with 4 shades of green from yellowish to dark green.
- Invented initially by IRRI, later was adapted to BD conditions, but are made at IRRI
- Practice is to compare at regular intervals the colour of rice leaf with the ones in the chart calibrated to show if urea is under or over applied during the growth period of rice and how much more to apply or delay more thus optimising N usage and often lowering it. For rice, leaf colour between 3rd and 4th shade shows that urea application is optimum. Farmers are advised to check leaf colour every 10 days or so.

# A Leaf Colour Chart



# Experimental Evidence on Benefits of LCC

- According to BRRI, LCC leads to a savings of 27 and 21 kg of urea per acre and additional output of 135 kg and 102 kg of paddy per acre of boro and aman rice land respectively
- Field level investigation shows that the savings in urea is around 25%, also there are additional benefits in terms of somewhat higher output, lower insect infestation with lower insecticide use. But the gains are somewhat variable over varieties, location (i.e., soil conditions and weather etc.)
- Some studies indicate that better management of fertiliser itself can lead to similar economic benefits to farmers, also that there are additional costs due to labour involved in examining leaves every 10-12 days

# Real Life Experience

- IRRI made the LCC technology available in 1999, yet it is only during the last 2/3 years that Ag Extension has shown interest
- A project soon to be wound up shows that some 483,000 charts have been distributed free to farmers and the savings had been by and large 20% or so in terms of urea use.
- Given the 2008 usage of urea in paddy that translates to at least 300 th mt of savings of urea against an import of 1.1 mn mt of urea in 2007/08, or a saving of 25% or so of imports and also a savings on the subsidy provided on the imported urea
- This also meant a lower emission of $N_2O$ of 2.71 th mt which is more than 800 th mt $CO_2$ equivalent on GWP basis. Add to that other co-benefits such as the additional output, lower pollution due to lower urea use, lower insecticide use
- Add also the lower use of energy to produce saved urea

# Assessment of the Practical Aspects of LCC in BD 1

- And yet, LCC has not caught on – why?
- At least 3 mn LCCs are needed, yet, only 483,000 imported and distributed so far and the project for doing that is also ending without any idea if this will continue
- LCC intervention relates to only N use; while this itself is beneficial, actual level of benefits may depend on other systemic changes such as use rates of other fertiliser which will be even slower to be adopted by farmers.
- Use of LCC may lead to better nutrient balances and net returns go up somewhat. This may or may not be enough for farmers, however, to give up old practice.

# Assessment of the Practical Aspects of LCC in BD 2

- Conflicting message - subsidy on urea means farmers do not pay full price and are encouraged to use more urea - LCC tells farmers to lower use based on more objective judgments
- The lower use of urea goes against the interests of the fertiliser import lobby and they are quite powerful politically
- Ag Extension so far has made no assessment of the barriers to adoption of LCC – we really do not know exactly why farmers are not grabbing it up. One reason could be the shortage of supply as there is no supply except through the Government
- Nor have they decided whether this should be a regular feature of extension practice
- Furthermore, varieties differ in their optimum N use and same dosage may not be suitable for all. Not much research has been done on fine-tuning LCC

# In Conclusion

- **Experience shows that price gives the strongest signal; higher prices of urea make farmer more responsive to ways for lowering usage – harmonisation of subsidy policy with LCC popularisation may be necessary – other means such as biofertiliser may be needed - but that is more complex than LCC**
- **Massive awareness building & demonstration are needed at the ground level to make even a simple LCC to be effectively used**
- **Technology transfer architecture should find ways of improving national extension capability**
- **But perhaps more importantly, there may not be *a technology*, rather a package of practices as the adoption of any specific technology may necessitate changes in many areas of the enterprise whether in industry or in farming and that is time consuming – technology transfer has to be a dynamic process not a static one**

# THANK YOU