DDGS Quality

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I took slides from following presenters

- Dr HS Jat, Director, ICAR Indian Institute of Maize Research, Ludhiana
- Mr. Sunil Duggal, All India Distillers Association, Delhi
- Dr. D. Chandrasekaran, Retired Professor, Namakkal
- Dr. Nataraja H.B., Higain Feeds, Bengaluru

- **Feed of the Future.**
- **For India By India**

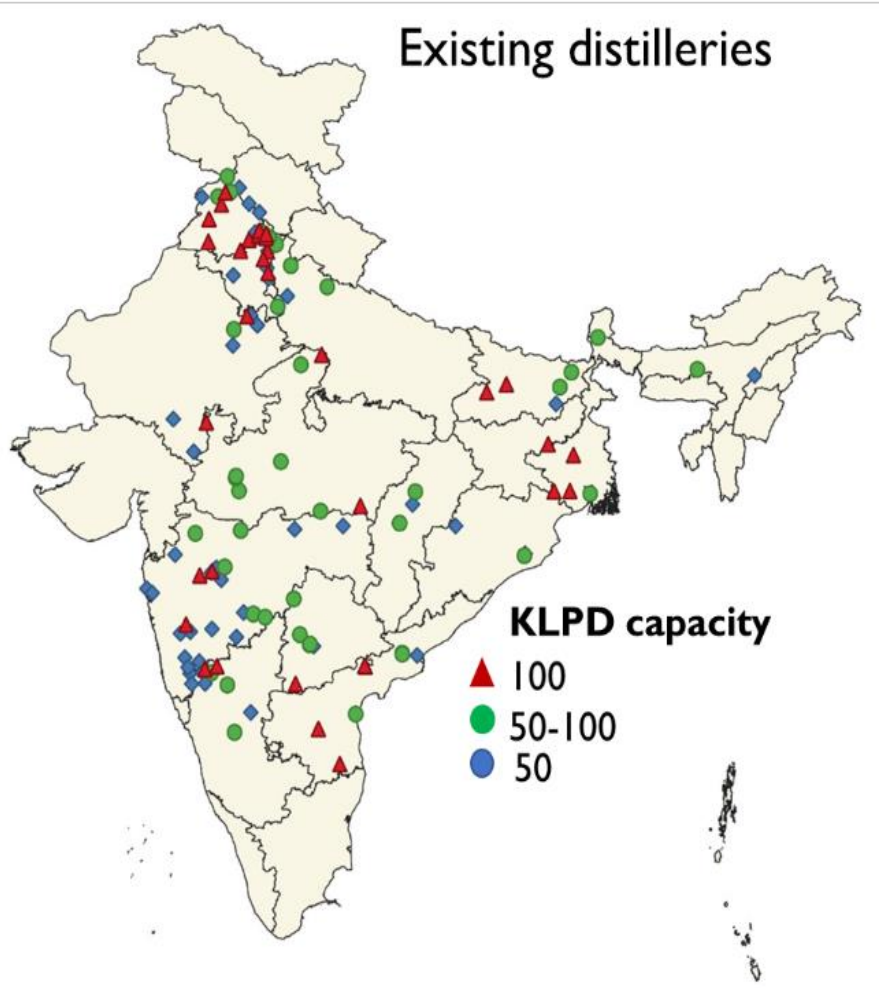
The Opportunity

- The Ethanol for petrol (EBP) programme is an ambitious initiative of GOI aimed at achieving 20 % ethanol blending with petrol by 2025/26.
- Currently we are at 13.5 % and the target is 15 % in 24/25
- A triple bottom line approach programme
  - Environment friendly- use of renewable resources, molasses and grains
  - Social cause-helps the farmer –both in remuneration and access to resources
  - Economic -Import substitution ,saves valuable FX for the country
- Currently ethanol is produced from molasses or grain (Rice & Maize)
- DDGS is extracted from rice /maize ethanol production
- High Source of energy – sparingly used in the feed industry

Maize is a focus crop for the Government of India . New MSP has been declared at Rs 22.25/g in the coming crop . The aim is to reach 65 MT by 26/27 whence there will be enough Maize for everyone . The future will be of plenty with stable prices

The challenge is to reduce input costs of Feed with alternate sources of protein (DDGS)

Availability across the country



- Well spread nationally
- All states covered
- Concentrated in Punjab/Haryana
- Access to local markets will ensure
  - Economic delivery cost due to lower freight
  - Consistent year round delivery

Why maize to be preferred for bioethanol?

- Rising ethanol production could impact sugar consumption
- Damaged food grains (DFG), not available in sufficient quantity

- High productivity potential
- Scope for enhanced production: yield & acreage enhancement
- Food security independent
- Round the year industry functioning
- Multiple cropping/year: 2+/yr, most part of India
- Reduced transport cost for OMCs: Local production & local consumption:
- Lesser water & environmental footprint (half that of sugarcane & rice): Environmentally sound
- By-product (DDGS) for feed industry

Sustainable production and farm profitability

Bioethanol from maize in India

ESY (Nov-Oct)	Ethanol from maize (Cr. Lit.)	Maize req. (million t)
2023-24	150	4.0
2024-25	250	6.6
2025-26	350	9.2

- High yielding maize
- High starch with better ethanol recovery
- Quality DDGS
- Climate resilient maize

National Biofuel Policy 2018

- **Production (Cr. Lit.)**: 494 Cr. Lit. in 2022-23; E11.7% (sugar juice (5%), cane molasses (5%) & DFG/rice (1.7%))

Target: E20% ethanol blending in petrol (EBP) by 2025

- **Demand (Cr. Lit.)**: 1,016 for E20 (NITI Aayog)
- **Capacity of grain distilleries (Cr. Lit.):** 258 (present) to 740 Cr. Lit. (2025-26)
- **Grain feedstock Req. (lakh t/yr)**: 165 for E20
- **Req. E30% by 2030**: 240 lakh t grains/year

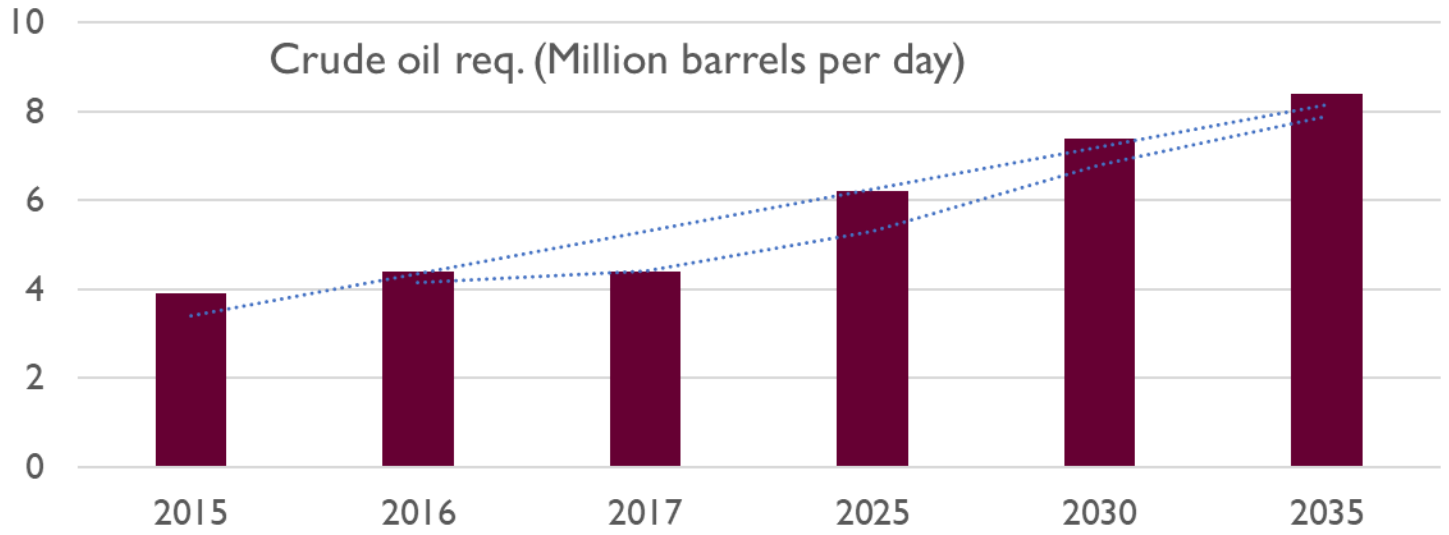
Increasing share of sugar to grain ratio in total supplies

- Grain based ethanol req. would be approx. 500 Cr liters by 2025-26

ESY	Realized				Projected			
	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
Sugar/Grain	95/5	91/9	86/14	83/17	73/27	63/37	55/45	50/50

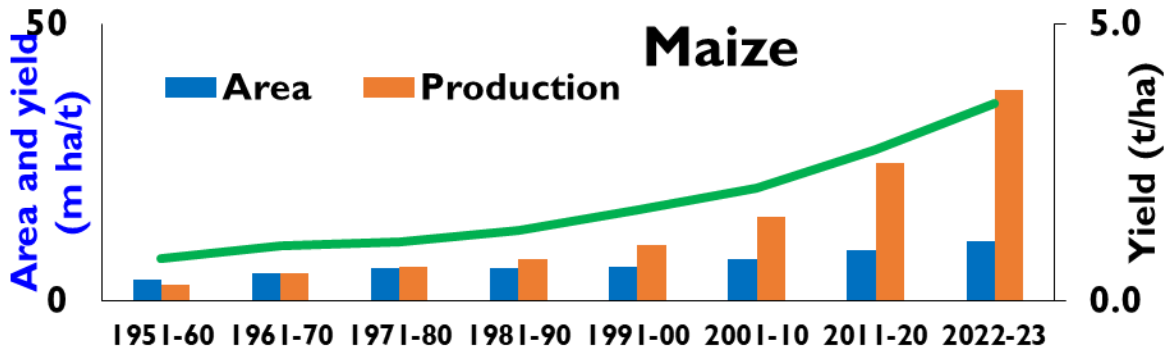
Demand and supply projections of the feed stock maize, for Ethanol blending for the next 10 Years

Particulars	Maize consumption/demand (million tonnes)			
	2020	2025	2030	2035
Poultry	14.5	20.9	27.9	40.0
Starch	4.2	5.1	6.0	7.3
Animal feed	3.9	4.5	5.0	5.8
Food processing	2.1	2.3	2.5	2.7
Food	3.8	3.9	3.9	4.0
Sub-total	**28.4**	**36.5**	**45.2**	**59.8**
Ethanol	0.0	9.2	18.0	20.0
Grand total	**28.4**	**45.7**	**63.2**	**79.8**
Crude oil req. (million barrels per day)		6.2	7.4	8.4



9-20 million tonnes

Maize Scenario in India



CAGR for 2016-17 to 2022-23

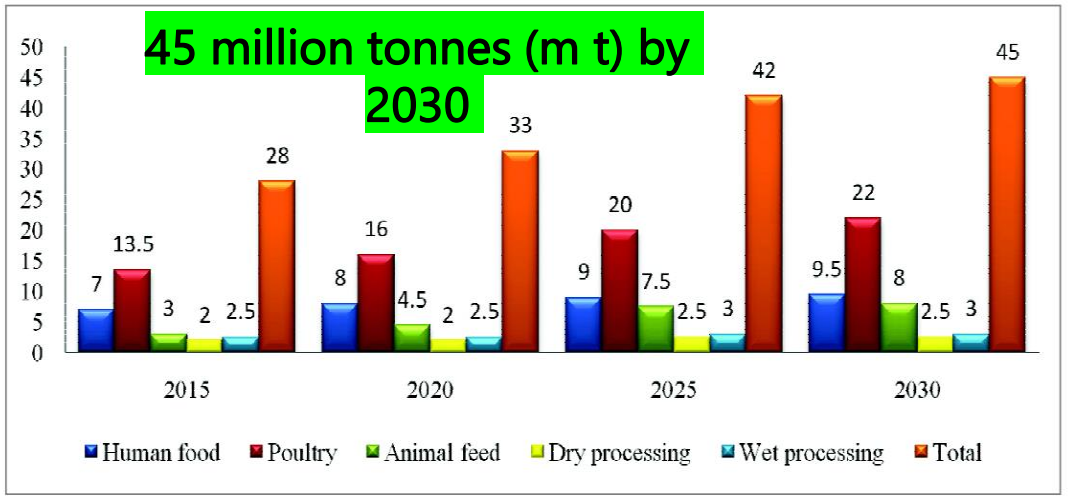
CAGR*	Wheat	Rice	Maize	Bajra	Jowar
Area	0.6	1.2	2.0	0.6	-6.1
Production	2.5	3.3	6.0	4.1	-0.7
Yield	2.0	2.1	3.9	3.6	5.7

Export

	Qty (mt)	Rs. Cr.	US$ Mill
2020-21	2.88	4676	635
2021-22	3.69	7615	1,021
2022-23	3.45	8987	1,116

Over 1950

Production : 16.0x
Area : 3.0x
Productivity : 6.0x



18-20 m t

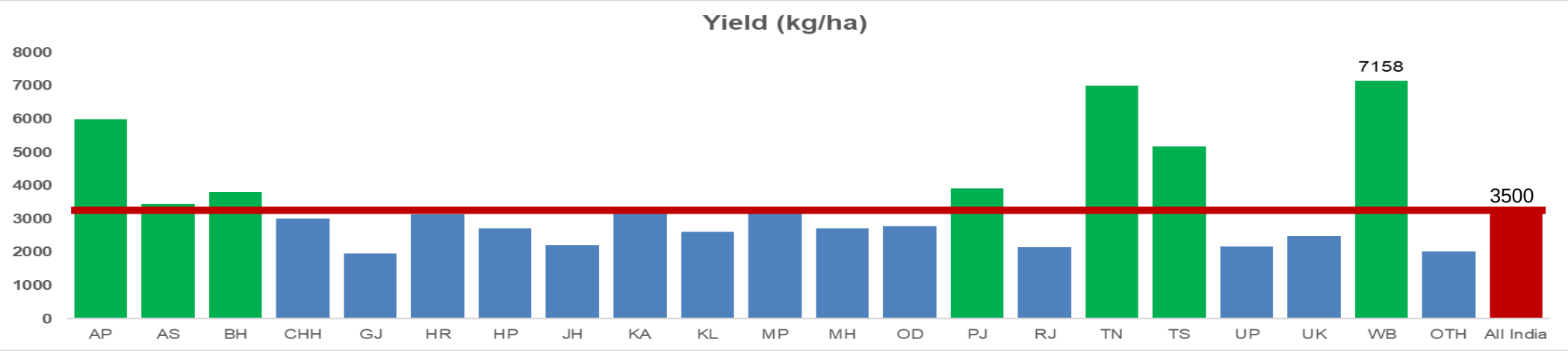
100 mt by 2047

63-65 million tonnes

Leading states for maize in India (2022-23)

Productivity in kg/ha (top 5 state)					
Kharif		Rabi		Summer	
Tamil Nadu	7460	West Bengal	8010	West Bengal	7300
Telangana	4554	Andhra Pradesh	7435	Tamil Nadu	6971
Andhra Pradesh	4518	Tamil Nadu	6971	Bihar	5360
Punjab	4363	Telangana	6622	All India	5289
Assam	3698	Bihar	5474	Karnataka	3550
All India	2962	All India	5284	All India	5289

Area (000 'ha) (top 5 state)					
Kharif (77.1% share)		Rabi (18.2% share)		Summer (4.6% share)	
Karnataka	1546	Maharashtra	424	Bihar	166
Madhya Pradesh	1448	Bihar	312	West Bengal	155
Rajasthan	941	Telangana	262	Uttar Pradesh	48
Maharashtra	881	Andhra Pradesh	248	Maharashtra	41
Uttar Pradesh	697	Tamil Nadu	184	Karnataka	39
All India	7931	All India	1875	All India	476



Aflotoxin Management – Key Steps

- Major Challenge in Maize DDGS on account of high moisture at source and storage practices
- Best Practices to be shared
- Industry has already put in
  - Feedstock acceptance standards
    - Moisture <14 % and Aflotoxin < 20 ppg
  - Education on storage protocols
  - Currently product trials on for treating aflotoxin
    - Results are encouraging
    - Should be in place soon

Aflatoxin in maize: Management

- ✓ Avoid Stresses: Proper water drainage, proper irrigation, avoid drought stress condition,
- ✓ Use of heat, drought, insect-pest resistant genotypes
- ✓ Manage Insect-Pests (cob borers & maize weevil) and weed management
- ✓ Adapt proper nutrient management
- ✓ Avoid late planting
- ✓ Follow Crop rotation with aflatoxin-non-susceptible crops
- ✓ Avoid mechanical damage to grains during harvesting
- ✓ Dry grains at appropriate levels of moisture (<14%) for safe storage at clean threshing floor/ dryers
- ✓ Maintain proper aeration in storage/ prevent insect damage durir storage
- ✓ Pre-harvest application of the Atoxigenic isolate *A. flavus*
- ✓ Top cutting (above the ears) at after physiological maturity (Quali fodder & fast ears drying)
- ✓ Avoid heaping of cob/grain

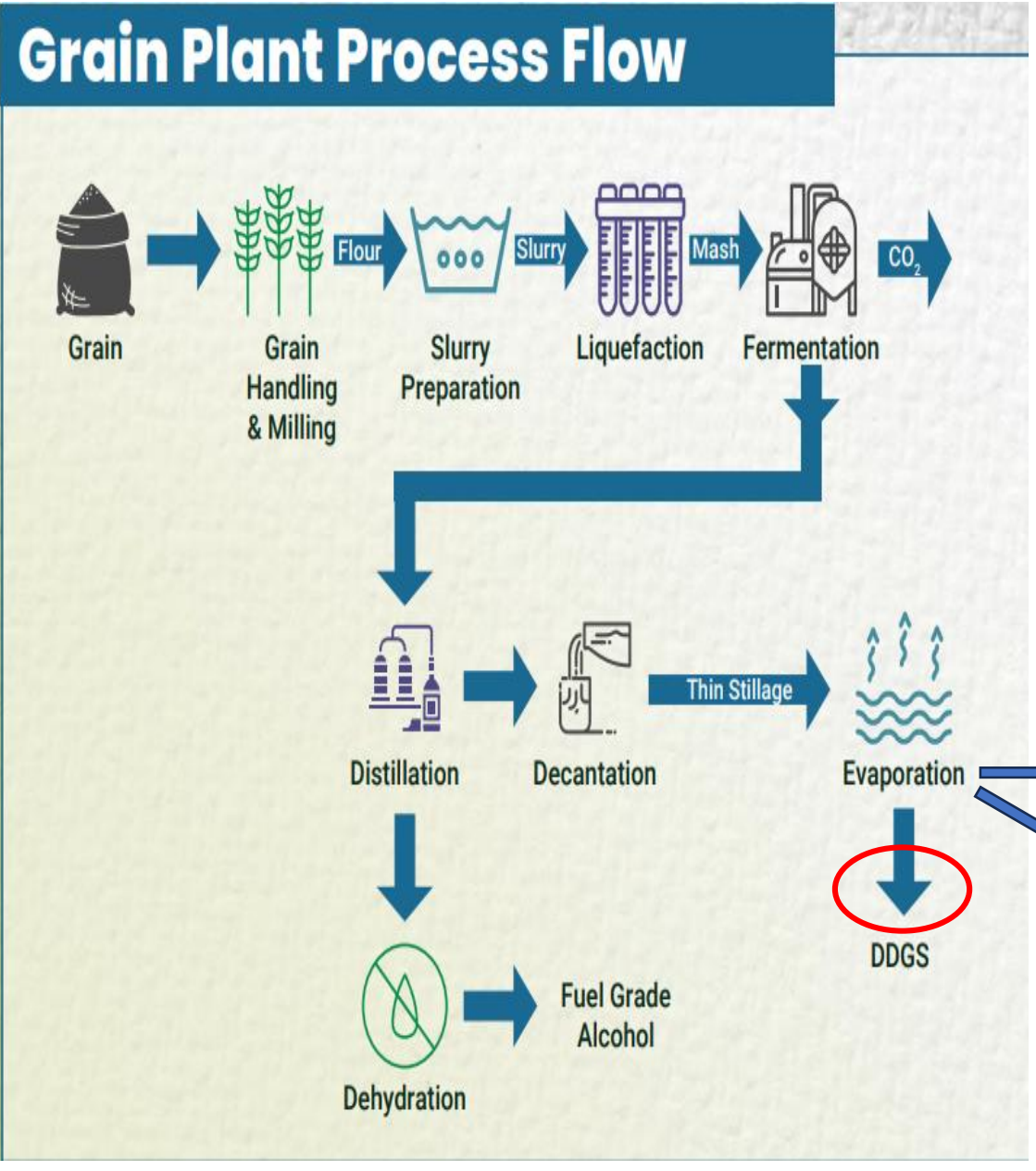
Quality management by ethanol producers

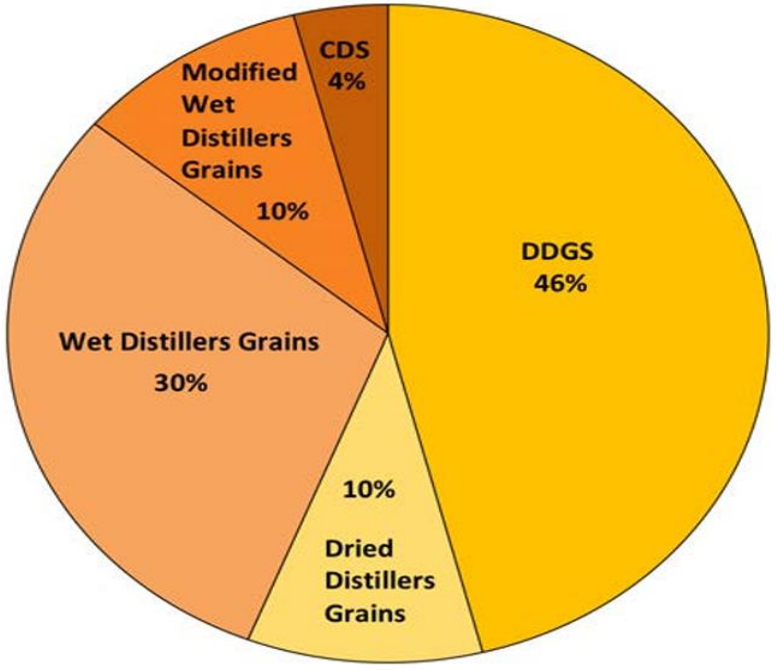
- Use of world class dryer systems before storage in silos for packing
- Specifications:
  - pH value which should be slightly acidic to neutral (6-7)
  - Color and odour-golden to brown to tan , slightly nutty aroma
  - Particle size and texture- should be uniform, not too fine or coarse
  - Foreign matter- metal , stones or other impurities
  - Moisture-10-12%
  - Protein-28-30%, fibre-10-15% and Fat-10-12%
  - Ash-5-7%- indicates level of mineral
- Hands free packing

Recipe for perfect animal feed

AIDA DDGS YATRA
DISTILLER'S DRIED GRAIN WITH SOLUBLES

Introduction





Proportion of various types of byproducts in ethanol production

If the coarse grain fraction of the whole stillage is dried without addition of solubles then product is called distillers dried grains (DDG)

If the coarse grain fraction of the whole stillage is dried with addition of solubles then product is called distillers dried grains with solubles (DDGS)

Source: Ministry of Petroleum and Natural Gas, GOI

Classification of DDGS and their chemical composition as per NASEM (2021)

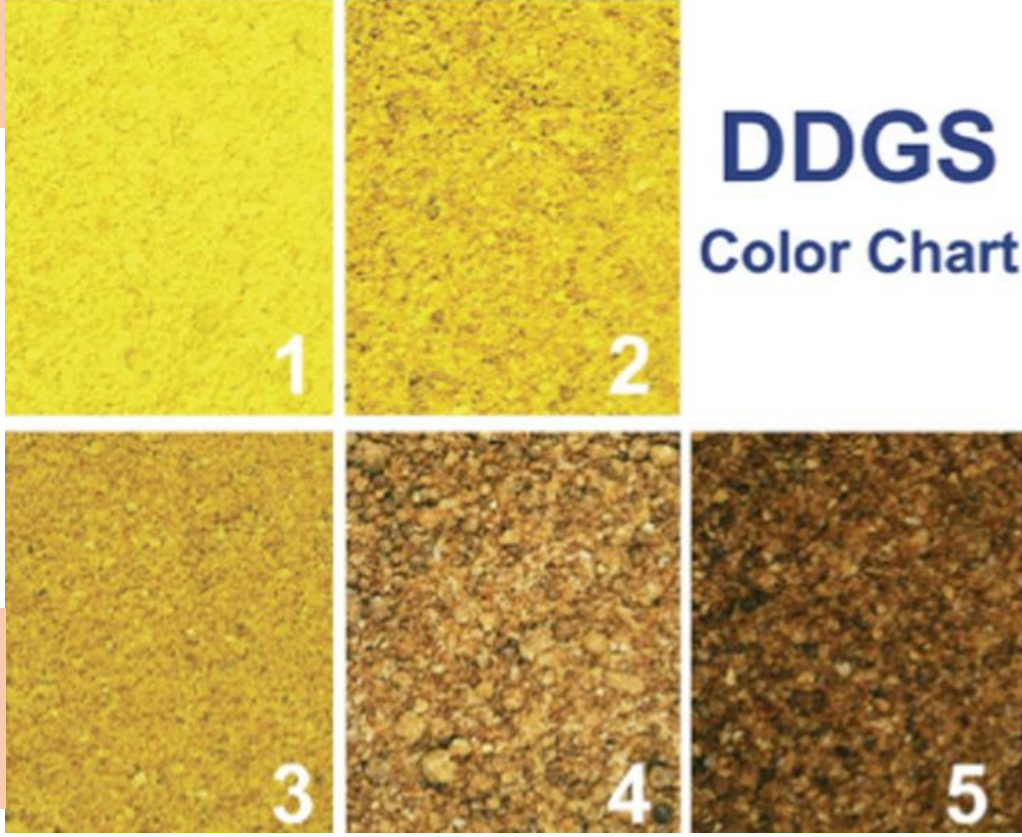
Attributes	DDGS (high fat) Feed code: NRC16F59	DDGS (high protein) Feed code: NRC16F60	DDGS (low fat) Feed code: NRC16F61
DM	89.1	91.1	89.9
Ash	5.4	4.0	5.3
CP	30.2	39	31.0
RUP % CP	47	47	47
NDF	32.1	37.6	30.8
ADF	14.6	17.7	14.8
ADICP	2.85	3.97	3.15
Starch	4.5	6.2	6.1
Crude fat	12.54	7.56	8.90
DE (Mcal/kg)	3.49	3.34	3.44
Ca	0.12	0.08	0.11
P	0.88	0.64	0.89
S	0.67	0.64	0.71

40% to 60% lower in crude fat

NASEM, 2021

Nutritional and physical properties of DDGS

- Physical properties
  - ✓ Color: very light to very dark (There is a relationship between the color of DDGS samples and amino acid availability)
  - ✓ Smell: normal to brunt or smoky



Opportunists to use DDGS as feed ingredients

Nutritional profile:

- CP approximately 30% (73 % RUP and low level of ADIN)
- Highly digestible fiber 40% NDF and 11% fat
- Non starch polysaccharides (26 %)
- **Low lysine level** (1) **Maize DDGS**: Lysine and tryptophan 2) **Wheat DDGS:** Lysine and threonine
- Higher amount of available phosphorus

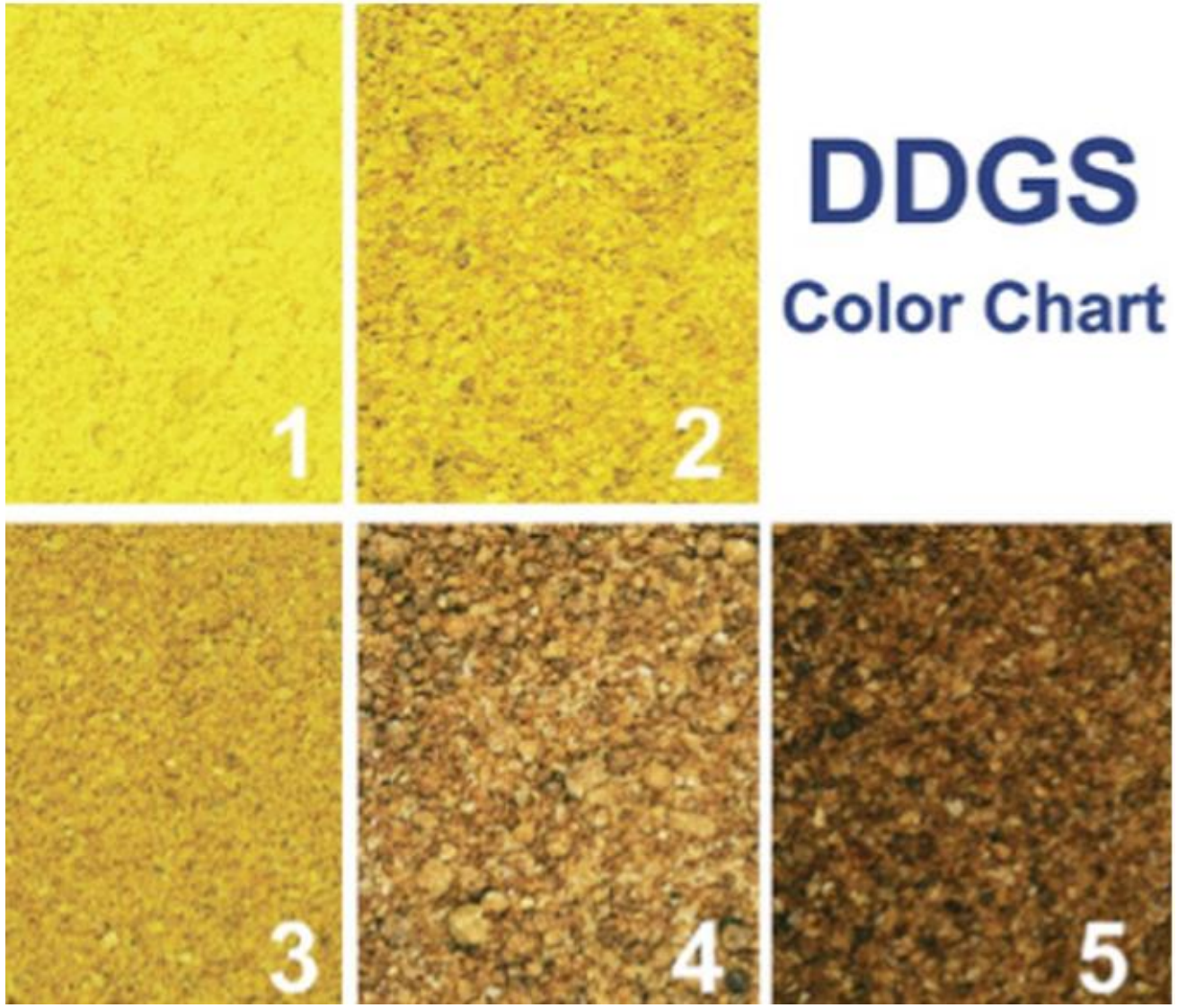
NRC, 2007

PHYSICAL PROPERTIES OF GOOD DDGS

Colour: Very light to very dark (There is a relationship between the color of DDGS samples and amino acid availability)

Smell: Normal to brunt or smoky

(Source: US Grain Council DDGS Handbook 2018)



COLOUR AND SMELL AS INDICATOR OF DDGS QUALITY

(Source :Hunterlab.com website)

Factors affecting nutritional and physical properties of DDGS

Type of grain and their composition

How much solubles are being added

Modification in Processing Technologies

- Fine grinding, germ and germ-fiber removal
- Enzymatic milling processes
- Dilute-acid pretreatment (sulphuric acid increased sulphur content)
- Type of fermentation (continuous vs batch)
- Drying temperature and duration (the darker the color of DDGS more heat damage to protein)
- Processing technologies of the plant to ferment starch

Challenges to use DDGS in animals feed

There is no standard nutrient profile available for DDGS

High risk material for mycotoxin contamination (3-4 times higher than grains)

Chemical composition is highly variable

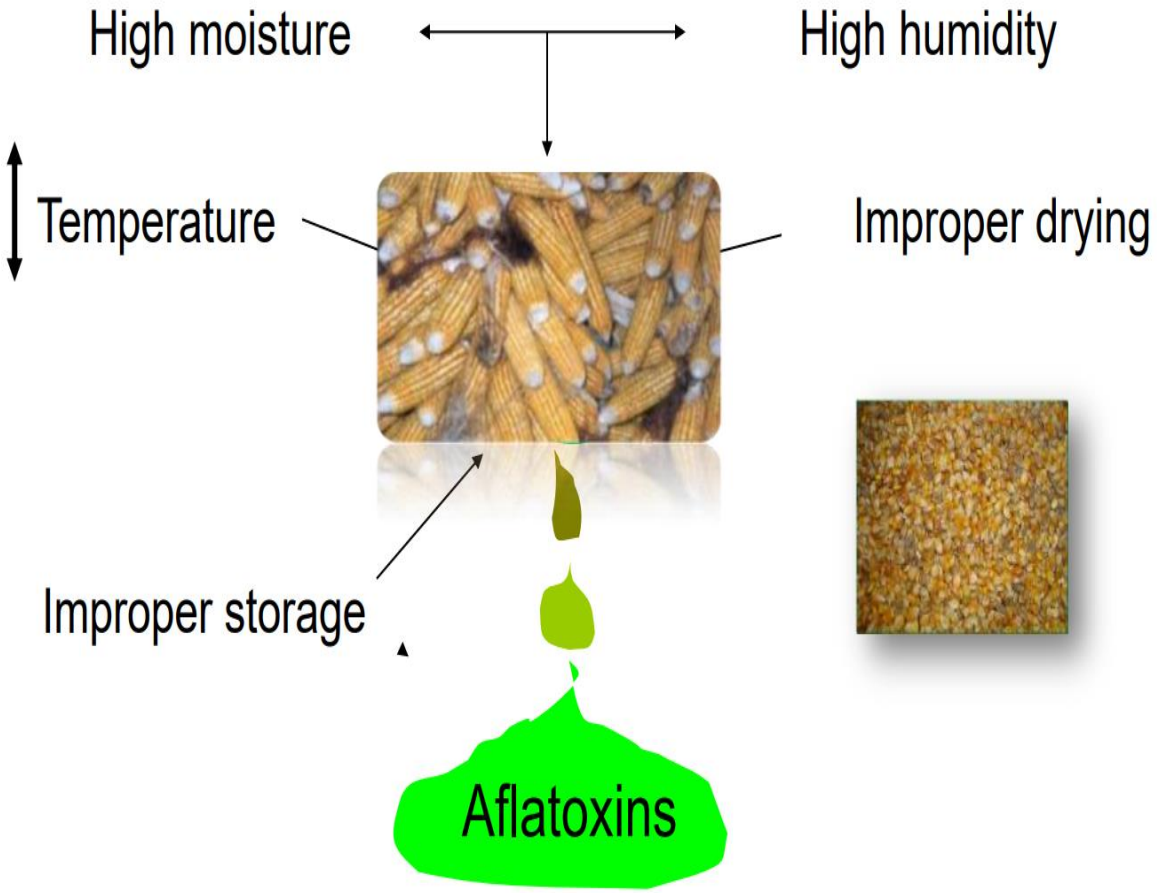
High level of unsaturated fatty acids makes DDGS more susceptible oxidation

New Ethanol Plants having new technology along with R&D in toxicology will address the above issues

BIS Regulations for Aflatoxin B1 both in Dairy and Poultry feed should be 20 ppb

1 to 6% of Aflatoxin B1 present in the Dairy feed is transferred to milk as Aflatoxin M1

0.1 to 0.2% of Aflatoxin B1 present in Poultry feed is transferred to eggs and meat



Good Manufacturing Practices and Storage of Feeds

- Spray mould inhibitor
- Moisture content less than 12 %
- Removes all waste material

RICE DDGS INDIAN SAMPLE ANALYSIS REPORT

Region	No. Of Samples	Average Proximate values (%)					
		Fat	Moisture	Protein	Ash	Fiber	Sand & Silica
East	18	**2.54**	**10.51**	**46.63**	**4.46**	**2.98**	**0.74**
Range		1.59 - 4.23	8.63 - 12.89	44.85 - 47.73	3.25 - 7.23	1.30 - 3.85	0.30 - 1.79
West	26	**2.20**	**9.86**	**44.37**	**4.70**	**3.58**	**0.88**
Range		1.35 - 3.29	7.93 - 11.98	42.18 - 46.82	3.28 - 6.29	2.37 - 4.47	0.45 - 1.18
North	31	**2.19**	**10.32**	**44.32**	**3.95**	**3.50**	**0.35**
Range		1.45 - 4.40	9.49 - 12.95	38.09 - 47.96	3.18 - 5.59	1.89 - 4.00	0.19 - 0.75
South	19	**3.26**	**9.76**	**44.53**	**4.87**	**3.27**	**0.94**
Range		1.99 - 6.63	8.00 - 12.37	41.42 - 47.14	3.62 - 5.84	1.69 - 4.89	0.39 - 2.27

Region	No. Of Samples	Average Total Amino acid values (%)											
		MET	CYS	M+C	LYS	THR	TRP	ARG	ILE	LEU	VAL	HIS	PHE
East	18	**1.14**	**0.92**	**2.02**	**1.51**	**1.67**	**0.55**	**3.12**	**1.87**	**3.55**	**2.60**	**1.01**	**2.31**
Range		1.09 - 1.21	0.87 - 1.01	1.90 - 2.14	1.37 - 1.75	1.55 - 1.85	0.51 - 0.62	2.85 - 3.44	1.75 - 2.05	3.30 - 3.91	2.44 - 2.80	0.91 - 1.10	2.15 - 2.52
West	26	**1.10**	**0.94**	**1.99**	**1.52**	**1.66**	**0.56**	**3.05**	**1.86**	**3.59**	**2.57**	**1.02**	**2.31**
Range		0.95 - 1.21	0.83 - 1.06	1.79 - 2.18	1.27 - 1.77	1.48 - 1.83	0.49 - 0.62	2.68 - 3.46	1.66 - 2.06	3.16 - 4.17	2.30 - 2.86	0.88 - 1.80	2.05 - 2.55
North	31	**1.12**	**0.89**	**1.96**	**1.43**	**1.62**	**0.54**	**2.95**	**1.83**	**3.47**	**2.54**	**0.96**	**2.28**
Range		1.06 - 1.18	0.87 - 0.93	1.91 - 2.07	1.36 - 1.54	1.55 - 1.68	0.52 - 0.56	2.82 - 3.17	1.78 - 1.89	3.35 - 3.62	2.48 - 2.65	0.91 - 1.01	2.22 - 2.33

Aflatoxin B1(ppb)	Fumonisins(ppm)	Ochratoxin(ppb)	T2 Toxin(ppb)	Zerolene(ppm)	DON(ppm)
90	30	250	200	10	400

Chemical composition of various DDGS

Parameter	Corn DDGS	Mixed DDGS	Rice DDGS
DM	87.6-93.5	87.3-92.6	89.691.4
CP	27.1-36.4	33.8-38.3	44.7-48.4
EE	6.5-11.8	4.4-5.0	5.5-6.5
Ash	5.4-9.0	8.0-10.2	4.01-5.03
NDF	30.2-39.7	28.9-31.2	40.5-45.60
ADF	8.9-11.9	11.5-12.3	12.9-16.82
CF	6.4-9.5	5.6-7.6	9.12
Starch	2.9-13.9	<1.0-3.7	-
Total sugars	5.4-12.6	9.9-14.2	-
Total NSP	24.2-29.1	23.8-25.7	-
S	0.72	0.37	0.55
Ca	0.05	0.15	0.13-0.70
P	0.77	0.92	0.35-1.34

BIS standards are being finalized

Pedersen *et al.*, 2014

Amino acid profile DDGS vs soybean meal

Parameter	Corn DDGS	Rice DDGS	Soybean meal
Arginine	1.05	1.47	3.48
Valine	1.63	1.12	2.25
Histidine	0.70	1.01	1.26
Isoleucine	1.52	0.93	2.15
Leucine	2.43	2.94	3.61
Lysine	0.77	0.64	2.95
Methionine	0.54	0.61	0.64
Phenylalanine	1.64	1.28	2.40
Threonine	1.01	0.92	1.83
Tryptophan	0.19	0.24	0.64

Nutritionists to adjust lysine in required amount for mono gastric feed formulations .

Pedersen *et al.*, 2014

Amino acid profile DDGS vs soybean meal

- DDGS has comparatively lower Lysine (0.64% to 1.23%) than Soya DOC
- Digestibility of Lysine in DDGS is quite lower i.e. 65% as compared to Lysine in Soya DOC i.e. 89%
- Tryptophan and arginine are the limiting amino acids in DDGS protein

Utilisation of DDGS in livestock feed

Items	Recommended level		
	Cattle	Layer	Broiler
Maize DDGS	Upto 20 %	Upto 15 %	Upto 25 %
Rice DDGS	Upto 20-25 %	upto 10 %	Upto 15 %

Note: DDGS in the poultry diet

Should be limited to **6%** in the starter

Should be **12%–15%** in the grower and finisher

Not more **than12%** of laying hens' diet

Note: DDGS in the cattle

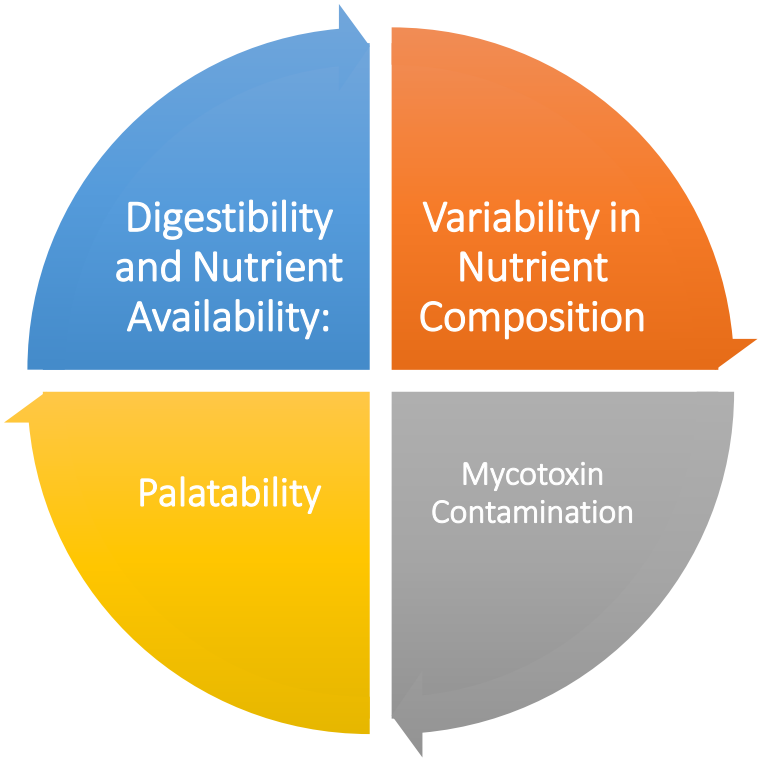
Pre weaned calves: 25 %

Heifers: 30 %

Dry cows: 15 %

Lactating cows: 20 %

Utilisation of DDGS in poultry



- **Poultry:**
  - ❖ DDGS improves meat and egg quality by enriching it with omega-3 fatty acids (Linoleic acid)
  - ❖ Improved phosphorous bioavailability and therefore less phosphorous excretion prevents environmental pollution

- **Drawbacks can be addressed :**
  - ❖ **High level of NSP:** Use of exogenous enzymes addresses this issue
  - ❖ **Amino acid composition** and ileal digestibility of limited essential amino acids by addition of additional lysine

Optimization of feed cost by DDGS inclusion

- DDGS can replace a portion of corn, soybean meal, and inorganic phosphorus
- DDGS is INR 15 to INR 20 cheaper than Soya DOC per Kg.
- By using DDGS judiciously and scientifically feed costs can be reduced by INR 300 to INR 600 per MT in layer diet and INR 500 to INR 1000 in the broiler diet.

Precautions while formulating feed with DDGS

- **Analysis:** Complete analysis of DDGS before use including amino acid profile
- **Quality:** Physical qualities like color, smell, texture etc. and chemical parameters like mycotoxin level, pH etc. need to be checked properly before incorporating into diet.
- The **storage** period of DDGS should be decided upon initial moisture and toxin levels.
- **Maximum inclusion level**: The maximum inclusion level of DDGS has to be finalized based on other raw material pricing, target production level, stress level, prevalence of any disease etc.
- **Toxin Binder**: Good quality toxin binder should be chosen to counter probable toxic effects.

FORMULATING TIPS WITH DDGS

1. **Storage condition:** Storage of DDGS mainly depends upon the initial level of moisture, season and storage area, and type of packaging material.
2. **Physical examination:** Physical parameters like pH, moisture, and mycotoxin level need to be considered.
3. **Proximate analysis:** Detailed analysis of parameters like crude protein, crude fiber, moisture, ether extract, and amino acid need to be done before formulating a diet.
4. **Maximum inclusion level in feed:** Maximum inclusion level of DDGS is dependent upon factors like age of birds, daily feed consumption, breed, season, inclusion level of other raw material and price, environmental factor, and disease scenario in the area.
5. **Target organ protection**

   a. Considering overall risk and threat factor protection against target organs like Liver, Kidney, Bursa, and Gut health needs to be considered. Sufficient levels of biotin, choline, and methyl donors need to be considered for liver health. To maintain immune status good quality toxin binder with multi-toxin binding and pesticide binding should be used in feed formulation.
   b. To have complete gut health protection probiotics having activity against Clostridium spp., Salmonella Spp., and *E. coli* species are needed.
   c. Considering variations in nutrient profile like Crude protein, Amino acid level and digestibility, ME content, and bioavailability of P, use of combination enzyme is best strategy to tackle economical and nutritional variation challenges.
   d. Enzyme solution having xylanase, amylase, beta glucanase, cellulase, amylase and multi-protease should be used. The use combination enzyme not only help to reduce the cost but also helps to mitigate the risk of anti-nutritional factor. It also helps to release extra sugar by breaking other NSP component like beta glucan, mannan, and oligosaccharides.

Use of r-DDGS in modern layers

Use of r-DDGS with **46 % CP, 20-50 wk, Iso-Caloric, AA equated**

Level	0%	4%	8%	12%	16%
Egg %	96.1	97.0	96.2	96.5	91.6
Feed Intake/bird	116	116	116	114	111
Feed/Egg	121	119	120	118	121
Egg Wt.	58.4	58.0	57.5	55.9	54.4
Feather Score	1.278	1.337	1.512	1.627	2.288

Personal Communication-SV Rama Rao, DPR

Conclusions

- DDGS in poultry feed offers opportunities to be used as a source of energy, protein and available phosphorus but requires careful formulation and quality control due to nutritional variability.
- Monogastric animals benefit from enzyme supplementation and optimized amino acid composition.
- DDGS's nutritional benefits enhance its potential as a valuable, sustainable feed ingredient.


Thanks