2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

2010 Grazing School for Milk Producers

Soil fertility and nutrient cycling in grazing systems

Dennis Hancock
Extension Forage Specialist
UGA – Dept. of Crop and Soil Sciences

"What's in the soil, is in the plant, is in the animal, …."

Plant Nutrients

Macro- (Primary)

Element	Available Form
Oxygen	O_2, OH^-
Carbon	CO_3^{-2}, HCO_3^-, CO_2
Hydrogen	H^+, OH^-
Nitrogen	NO_3^-, NH_4^+
Phosphorus	HPO_4^{-2}, $H_2PO_4^-$
Potassium	K^+

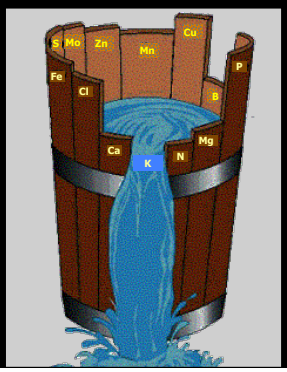
Micro- (Trace)

Element	Available Form
Iron	Fe^{+2}, Fe^{+3}
Copper	Cu^{+2}, Cu^+
Zinc	Zn^{+2}
Manganese	Mn^{+2}, MnO_4^-
Molybdenum	$HMoO_4^-$, MoO_4^{-2}
Boron	H_3BO_3, $B_4O_7^{-2}$
Chlorine	Cl^-

Meso- (Secondary)

Element	Available Form
Calcium	Ca^{+2}
Magnesium	Mg^{+2}
Sulfur	SO_4^{-2}

Liebig's Law of the Minimum



Soil Test and Follow Fertility Recommendations

Sample hay and crop fields every year and 1/3 of your paddocks each year.

Soil Test Ranges

	Low	Med	High	V. High
Phosphorus	0-30	31-60	61-100	101+
Potassium	0-60	61-150	151-250	250+

	Low	Adequate
Calcium	0-200	201+

	Low	Med	High
Magnesium	0-30	31-60	61+

Coastal Plain

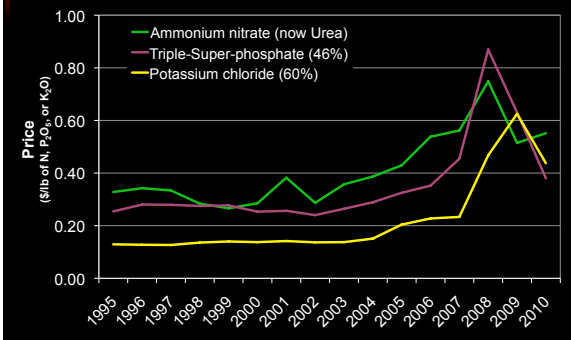
Dr. Dennis Hancock
Extension Forage Agronomist

THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

"All Kinds of Wacky"



Costs Increase When Soil Fertility Decreases

Let's assume P & K have been equally taken care of or equally neglected. So, let's consider bermudagrass fertility.

P & K Fertility	Recommended Rate of N	Recommended Rate of P_2O_5	Recommended Rate of K_2O	Total Cost
	(lbs/acre)	(lbs/acre)	(lbs/acre)	($/acre)
V. High	250	0	0	125
High	250	30	150	201
Medium	250	60	200	233
Low	250	80	250	262

Assumptions: Using 28% UAN ($280/ton), DAP ($500/ton), and Muriate of Potash ($525/ton).

What affects pasture cost?

$$\text{Pasture Cost (\$/lb)} = \frac{\text{Total Cost (\$/Acre)}}{\text{Forage Yield (lbs/Acre)}}$$

The False Economy of Shortcuts

	Cost of Production Compared to Average						
Yield	70%	80%	90%	100%	110%	120%	130%
130%	54	62	69	77	85	92	100
120%	58	67	75	83	92	100	108
110%	64	73	82	91	100	109	118
100%	70	80	90	100	110	120	130
90%	78	89	100	111	122	133	144
80%	88	100	113	125	138	150	163
70%	100	114	129	143	157	171	186

Get your priorities right!

Maintaining soil pH is job #1.

- Nutrient availability
- Soil structure
- Soil biological activity
- Aluminum toxicity

Dr. Dennis Hancock

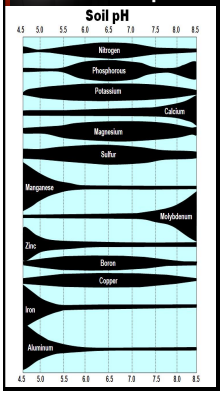
Extension Forage Agronomist

THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

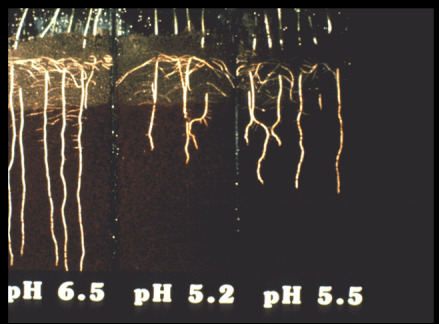
How Soil pH Affects Availability of Plant Nutrients



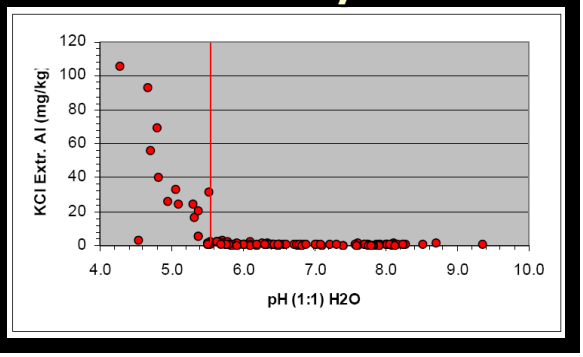
The difference of a soil pH of 5.6 vs. 6.2:

Nutrient	Amt. Used Annually (Lbs/acre)	Unit Price ($/lb)	Dec. in Efficiency	Value of Decrease ($/acre)
N	300	$0.50	35%	-$53
P_2O_5	60	$0.43	50%	-$13
K_2O	250	$0.46	10%	-$12
			Total	-$78

Get at the Root of a Problem: Soil pH Problems

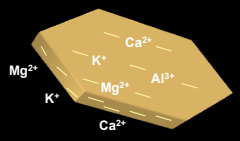


Low Soil pH = Aluminum Toxicity



How Soil Holds Nutrients

Soil Particle

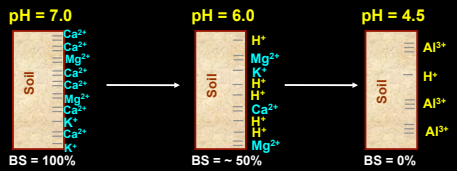


e.g., CEC = 10

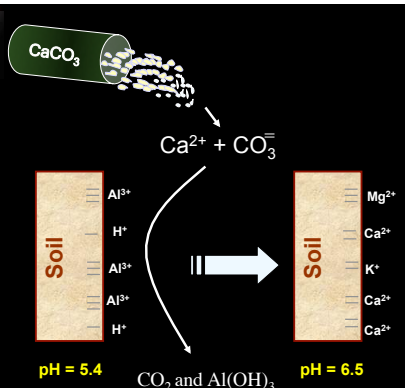
Organic Matter

e.g., CEC = 200

Soil Acidity and CEC



Strength of cations:
$Al^{3+} > H^+ > Ca^{2+} > Mg^{2+} > K^+$



Dr. Dennis Hancock

Extension Forage Agronomist

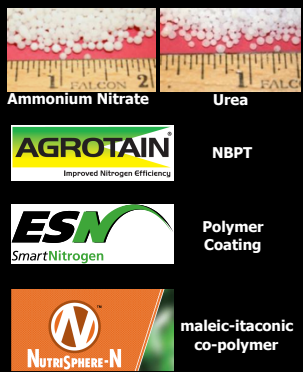
2010 Georgia Grazing School:

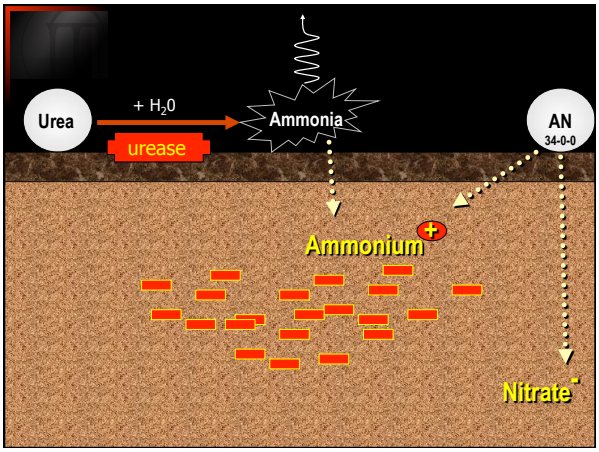
Soil fertility and nutrient cycling in grazing systems

Nitrogen Use

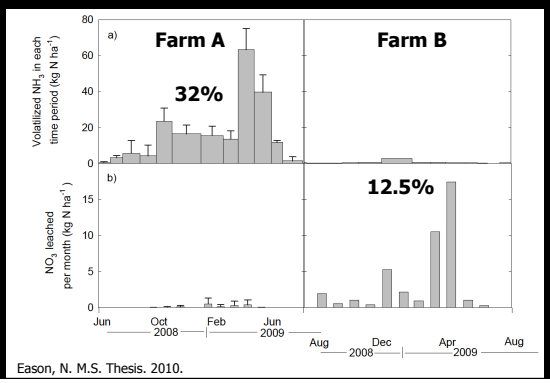
Use of Urea-Based Products

- Without AN, users of N face risky alternatives.
  - NH_3 volatilization loss
- Urease is abundant in thatch & organic layers
  - High N use in hay.
- Enhanced Efficiency N Fertilizer Products may reduce volatilization loss
  - Urease inhibition
  - Encapsulate & release





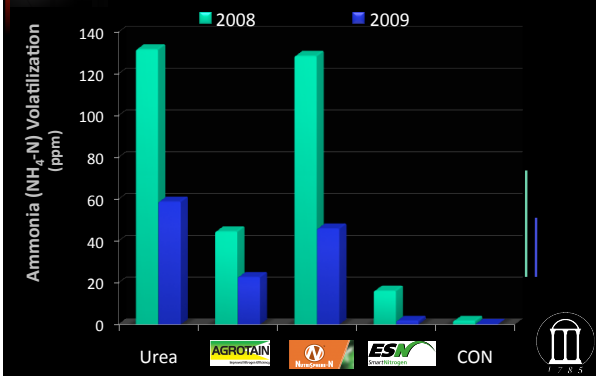
N Loss to Volatilization



Eason, N. M.S. Thesis. 2010.

Ammonia Volatilization Trap Data

2008-2009 (avg. over two locations)



Additional Data

Agrotain Treated Urea
as compared to urea applied in the same way (averaged over 4 site-yrs):

- Reduced ammonia volatilization by over 63%.
- Produced 11% more forage yield.
- Recovered 19% more of the applied N.
- Did not substantially affect crude protein content.
- Did not substantially affect the risk of nitrate toxicity.

Dr. Dennis Hancock

Extension Forage Agronomist

THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

Another Fertilization Trick

Split Your Nitrogen Applications!

- Long-term, this can increase yields by **5-10%** and increase NUE by **25-30%**
  - Especially important under extremes
    - Leaching
    - Volatilization (in the case of urea-based products)
    - Late freeze
    - Drought

Nitrogen Response: Rules of Thumb

Forage Type	N Response Above Critical Level*		
	Early Season	Mid-Season	Late-Season
	------- lb of DM/lb of N added -------		
Coastal bermuda	30-45	35-45	20-35
Tifton 85 bermuda	30-40	45-55	30-40
Annual ryegrass	5-12	10-20	15-30

* N fertilization above ~40, 50, or 25 lbs of N/acre for Coastal, Tifton 85 and ryegrass, respectively.

Cost Implications of Different Nitrogen Response Rates

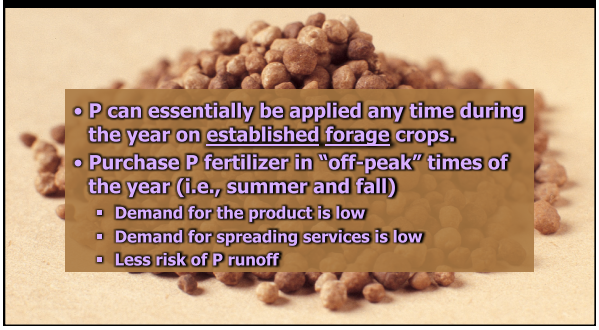
	Cost of N, $/lb of N			
	$0.50	$0.60	$0.75	$1.00
Nitrogen Response	N Cost of Additional Production			
lbs of DM/lb of N	---------- $/lb of DM ----------			
5	$0.100	$0.120	$0.150	$0.200
10	$0.050	$0.060	$0.075	$0.100
15	$0.033	$0.040	$0.050	$0.067
20	$0.025	$0.030	$0.038	$0.050
25	$0.020	$0.024	$0.030	$0.040
30	$0.017	$0.020	$0.025	$0.033
35	$0.014	$0.017	$0.021	$0.029
40	$0.013	$0.015	$0.019	$0.025
45	$0.011	$0.013	$0.017	$0.022
50	$0.010	$0.012	$0.015	$0.020
55	$0.009	$0.011	$0.014	$0.018

Value of the Substitute

Corn				
$/bu	$4.00	$4.50	$5.00	$7.00
$/lb	$0.071	$0.080	$0.089	$0.125
Corn Silage				
$/dry ton	$45	$50	$60	$75
$/lb	$0.023	$0.025	$0.030	$0.038
Ryegrass Baleage				
$/dry ton	$130	$150	$170	$200
$/lb	$0.065	$0.075	$0.085	$0.100
T85 Hay				
$/dry ton	$100	$120	$140	$175
$/lb	$0.050	$0.060	$0.070	$0.088

Another Fertilization Trick

Apply P in late summer or fall.



- **P can essentially be applied any time during the year on established forage crops.**
- **Purchase P fertilizer in "off-peak" times of the year (i.e., summer and fall)**
  - **Demand for the product is low**
  - **Demand for spreading services is low**
  - **Less risk of P runoff**

K is for Persistence

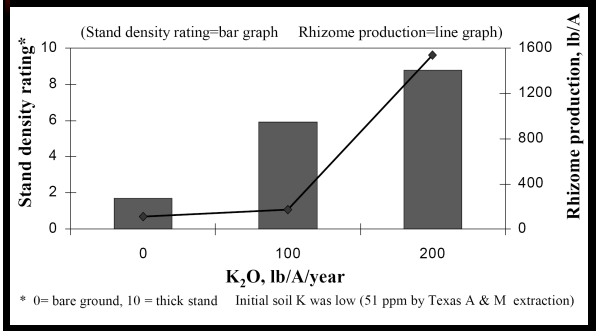
Dr. Dennis Hancock

Extension Forage Agronomist

2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

K is the Key to a Good Stand



Another Fertilization Trick

Split Your Potassium Applications!

40-50% in the Spring

50-60% in mid – late season

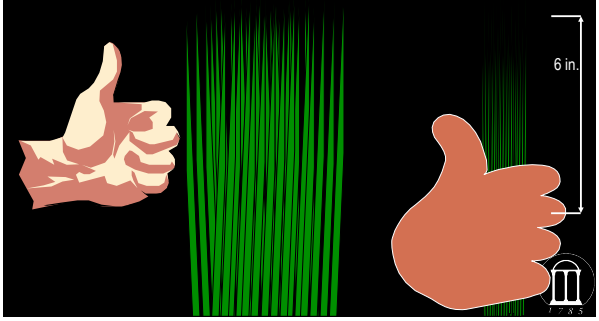
Troubleshooting

Good Zones
- Tissue Sample
- Soil Sample
- Other(?)

Bad Zones
- Tissue Sample
- Soil Sample
- Other(?)

Representative Samples
- ~ 20 similar specimens

Tissue Sampling



K and Nutrition for Late Gestation and Close-Up Cows

- Proper K conc. in bermudagrass to promote stand life is 1.8-2.0% or more.
- Close-up cows need a low DCAD (dietary cation anion diff.)
  - DCAD = (Na + K) – (Cl + S)
  - ~-10 – 15 meq per 100 g DM
  - K should be < 1.5% in the diet
- K nutrition is critical for heat stress
  - K should be > 1.9% during heat stress
- Grains, corn silage are typically low (<1.2%)
  - Brewer's grains are one of the lowest (<0.6%)

Chicken Litter Makes Good Fertilizer…

Dr. Dennis Hancock

Extension Forage Agronomist

THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

2010 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

Variability in Chicken Litter

- **"Book Number"**
  - **3-3-2**
- Range in % N
  - 1.1 – 4.9%
- Range in % P_2O_5
  - 0.9 – 4.8%
- Range in % K_2O
  - 1.2 – 4.0%

Source: Univ. of Ark. Ext. Bulletin FSA-8000.

Poultry Litter - Disadvantages

- Weed pressure does increase
  - Not a source of weed seed
  - Changes the fertility and makes broadleaf weeds more competitive.
- Potassium fertilization may not be adequate
  - Poultry Litter: 3-3-2
  - Ideal bermudagrass fertilizer: 5-1-4
- May result in excessive sulfur levels
  - Some evidence for a link to copper deficiency in cattle.

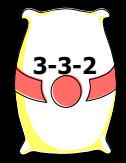
The Value of Litter

Pre 2005 Prices

- 60 # PAN x .28 x .5 = 8.40
- 60 # P_2O_5 x .22 x .8 = 10.56
- 40 # K_2O x .12 x .8 = 3.84
  - **Total = $22.80**

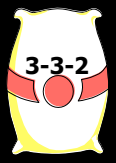
2010 Prices

- 60 # PAN x .50 x .5 = 15.00
- 60 # P_2O_5 x .43 x .8 = 20.64
- 40 # K_2O x .44 x .8 = 14.08
  - **Total = $ 49.72**

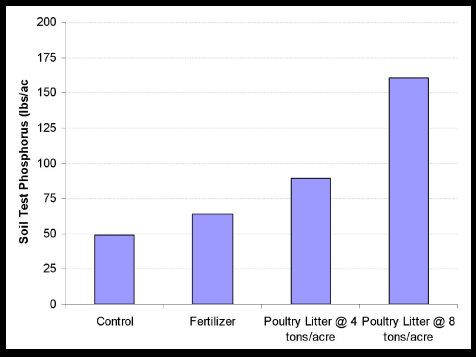


The Value of Litter

Other Nutrients ?
Organic Matter ?
Liming ?
Nematode Suppression ?



Too much of a good thing?



Benefits of Rational Grazing

1. Better utilization of forage
2. Growth rate of forage is optimized
   - Kept in linear/exponential growth phase
   - Higher yield of forage
3. Higher stocking rates
4. More animal gains/milk production per acre
5. Reduced feeding of conserved forage or supplements
6. Better persistence of desirable forages
   - Especially clover and legume species
7. Better weed suppression
8. Better manure distribution

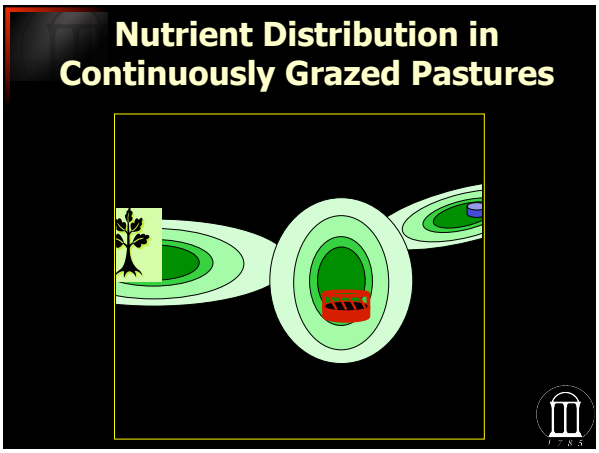
Dr. Dennis Hancock

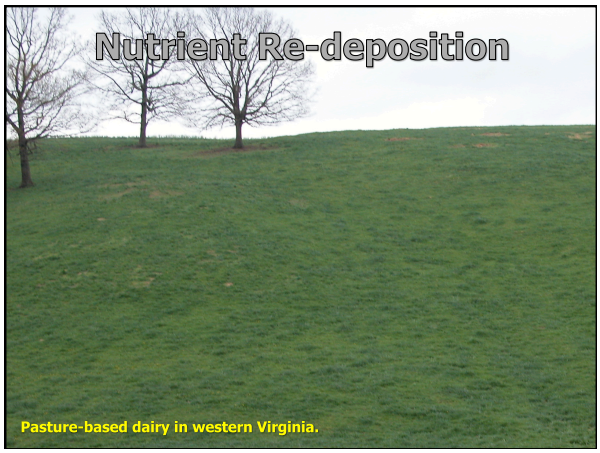
Extension Forage Agronomist

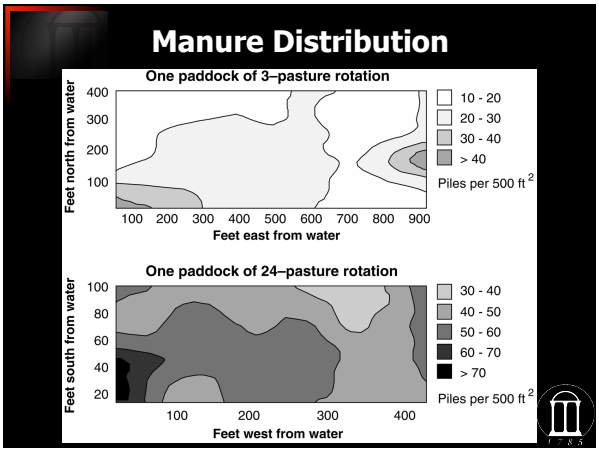
THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

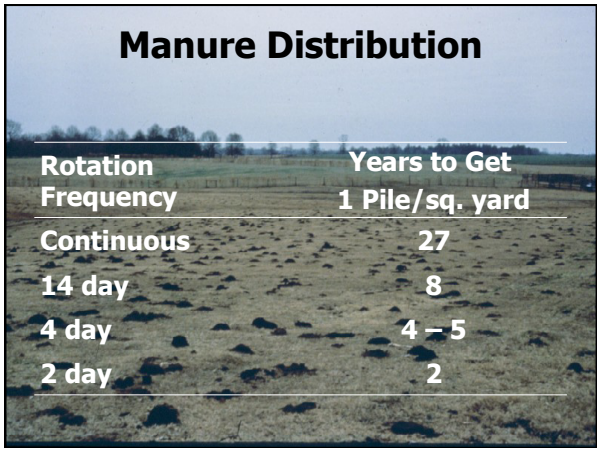
2010 Georgia Grazing School:

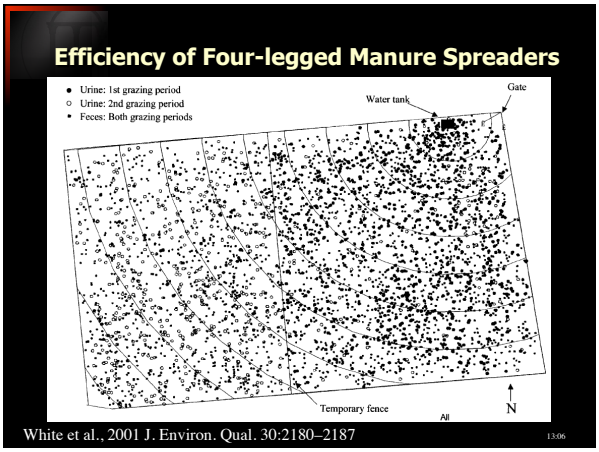
Soil fertility and nutrient cycling in grazing systems











Dr. Dennis Hancock

Extension Forage Agronomist