Evaluation of Methane and Nitrous Oxide Emissions from Different Water Management Practices in Irrigated Drill-Seeded Rice Systems

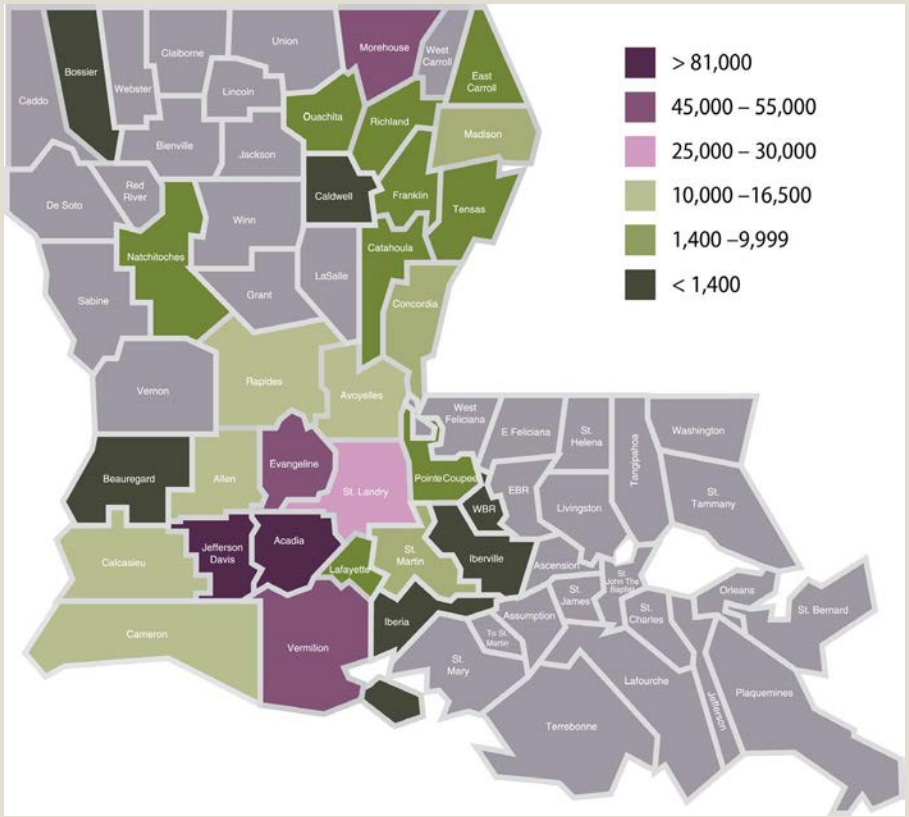
Supported by Louisiana Rice Research Board

Manoch Kongchum and Dustin Harrell

LSU AgCenter, H. Rouse Caffey Rice Research Station, Crowley, Louisiana

Louisiana Rice Production

- 3rd largest producer in the U.S. (behind Arkansas, and California)
- 1000+ growers
- Total production area (acres):
  - 476,497 (2020)
  - 420,000 (2021)
- Long grain dominant
- 100% irrigated



Louisiana Rice Production

- Rotation
  - Soybean, crayfish (south)
  - Soybean, corn (north)
- Planting methods
  - Dry seeding (drill-seeded ~75%)
  - Wet seeding (crayfish)
- Water management
  - Delayed flooding (south)
  - FIR – row rice (north)
- Rice varieties (2020-22)
  - CL153, Cheniere, CL111, CLL17, CLXL745

Objectives

To evaluate methane and nitrous oxide emissions and GWP from different water management practices of drill-seeded rice systems

Site and Field Management

- LSU AgCenter H. Rouse Caffey Rice Research Station, Crowley, Louisiana
- Plot size 4.67 ft. x 16 ft. (~1.4 m x 4.8 m), RCB 4 Reps
- Soil type: Crowley silt loam (Typic Albaqualfs)
  - pH (1:1 water)~7.2-7.4
  - O.M. ~1.15-1.75
- Fertilizer:
  - Main crop: 120 lb N/A (~135 kg N/ha), P (P_2O_5) and K (K_2O) at 60 lb/A (~68 kg/ha)
  - Ratoon crop: 90 lb N/A (~100 kg N/ha)
- Pest Management: as needed
- Three years (2018-2020)

Fertilizer and Water Management

- P and K – at planting 60 P_2O5 and 60 K_2O lb/A (~67 kg/ha)
- N (Urea)– 1-day preflood 150 lb N/A (~168 kg N/ha)
- Drill-seeded
- Water management treatments
  - Delayed flooding
  - AWD (naturally dry 2-3 times before heading)
  - Semi-aerobic
  - Furrow Irrigated Rice (row rice)
- Use indicator tube for reflooding (AWD)

Re-flooding indicator


Conventional or Delayed Flood


AWD


Semi-Aerobic


Furrow Irrigation

Gas sampling

- Static closed chamber technique
- Chamber size = 30 cm x 30 cm x 30 cm
- Base chamber has two holes in opposite direction near soil surface to equilibrate the water level - retain in the plot entire season
- Base chamber can be stacked up at later growth stages
- Top chamber has multiple rubber septum for gas sampling port, for releasing pressure, and installing thermometer
- Collected 15 mL of gas sample at 0, 30, and 60 minutes after closing the top chamber - twice a week
- Stored in pre-evacuated vials
- Analyzed CH_4 and N_2O using Gas Chromatograph (equipped with FID/ECD)

Calculations

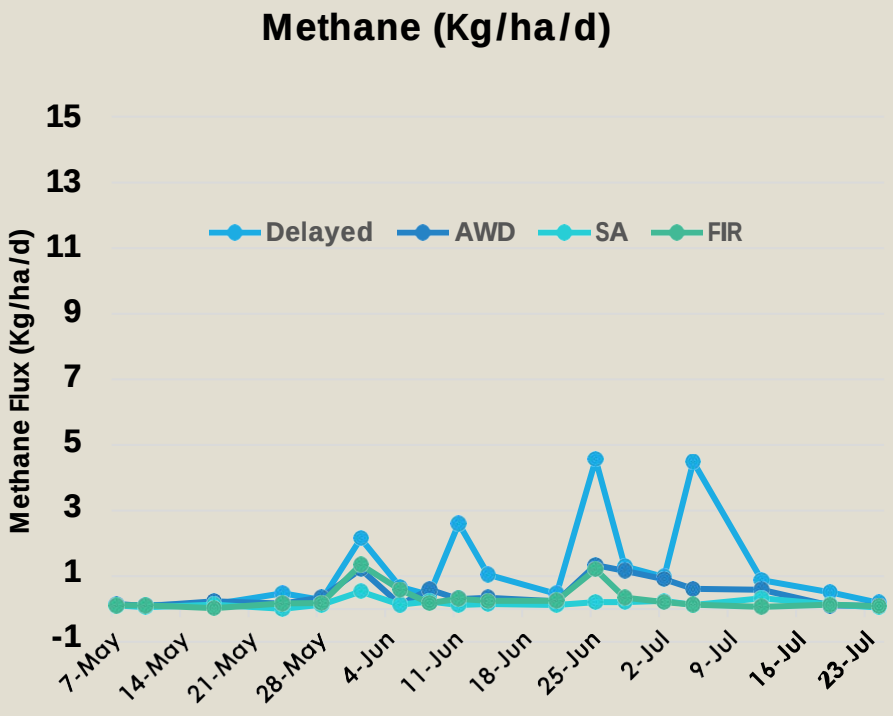
- Flux (mg/ha/d)

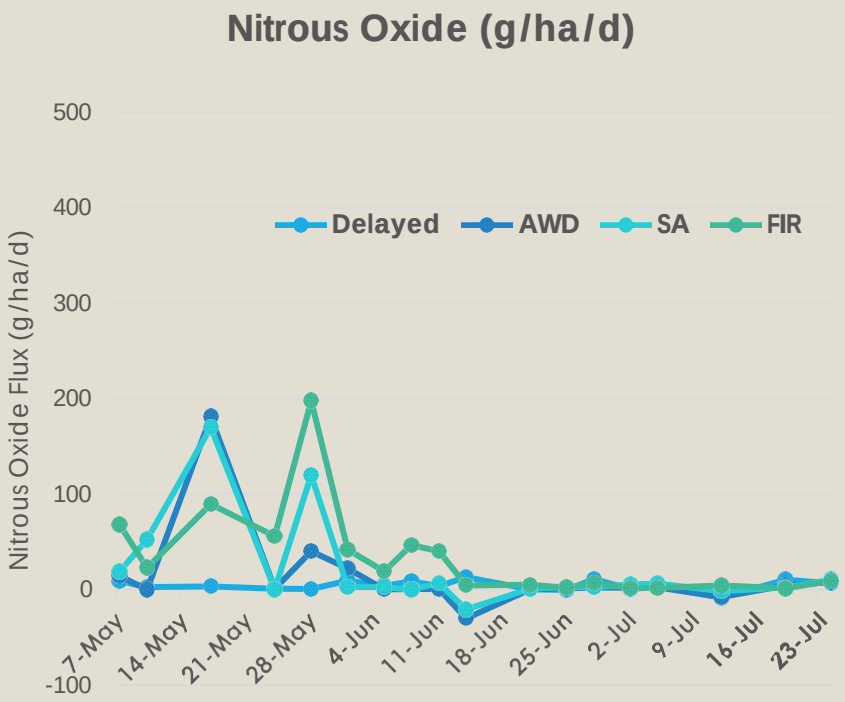
$$= \left(VC * \frac{\Delta C}{1{,}000{,}000}\right) * \left(\frac{24}{\Delta T}\right) * \left(\frac{MW}{82.0577 * T}\right) * \left(\frac{10{,}000}{AC}\right)$$

  - VC: volume of chamber (mL)
  - ΔC: GHG change in concentration (ppmv)
  - ΔT: Sampling time (h)
  - MW: molecular weight of gas (mg)
  - AC: Area of chamber (m2)
  - T: Temperature in Kelvin
- Seasonal emissions
  - Assume the flux between two sampling points are linear
- GWP
  - CH4, and N2O to CO2 equivalent
    - Conversion factors are 28 and 265

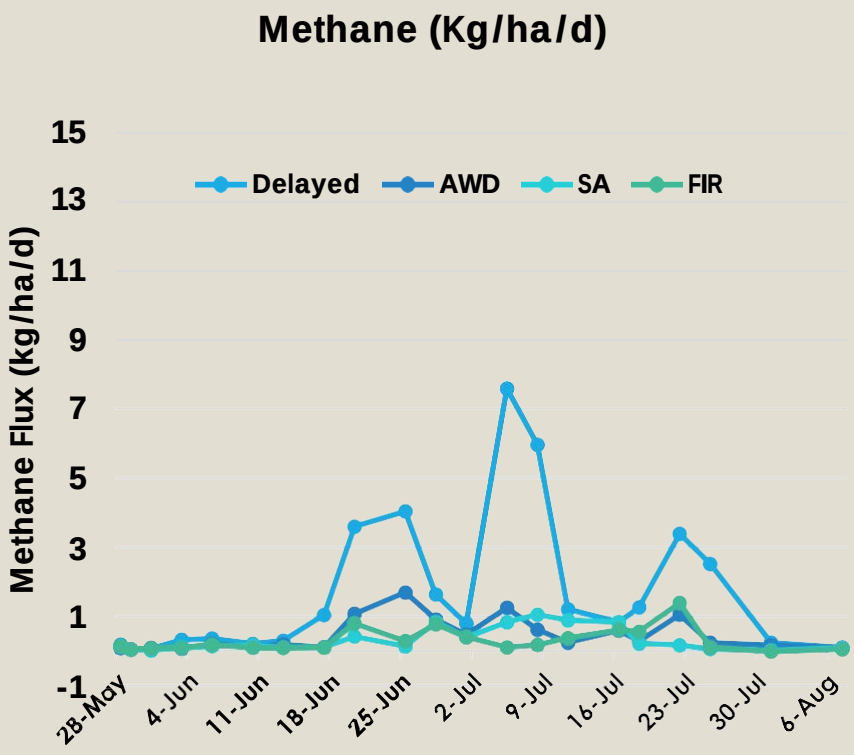
Results

2018


Methane (Kg/ha/d)
Methane Flux (Kg/ha/d)
15
13
11
9
7
5
3
1
-1
Delayed
AWD
SA
FIR
7-May
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul


Nitrous Oxide (g/ha/d)
Nitrous Oxide Flux (g/ha/d)
500
400
300
200
100
0
-100
Delayed
AWD
SA
FIR
7-May
14-May
21-May
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul

2019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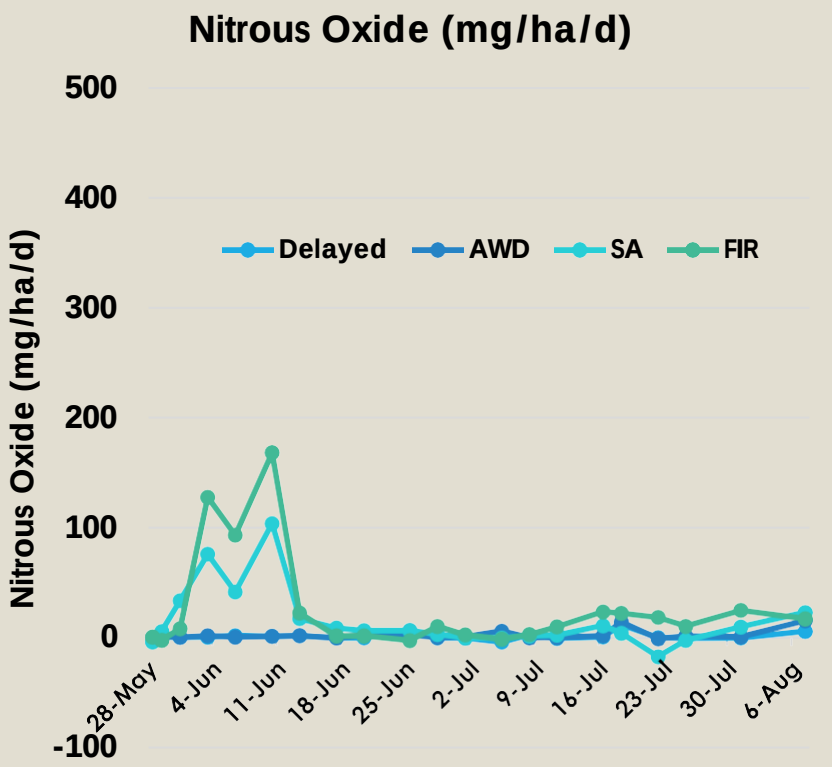
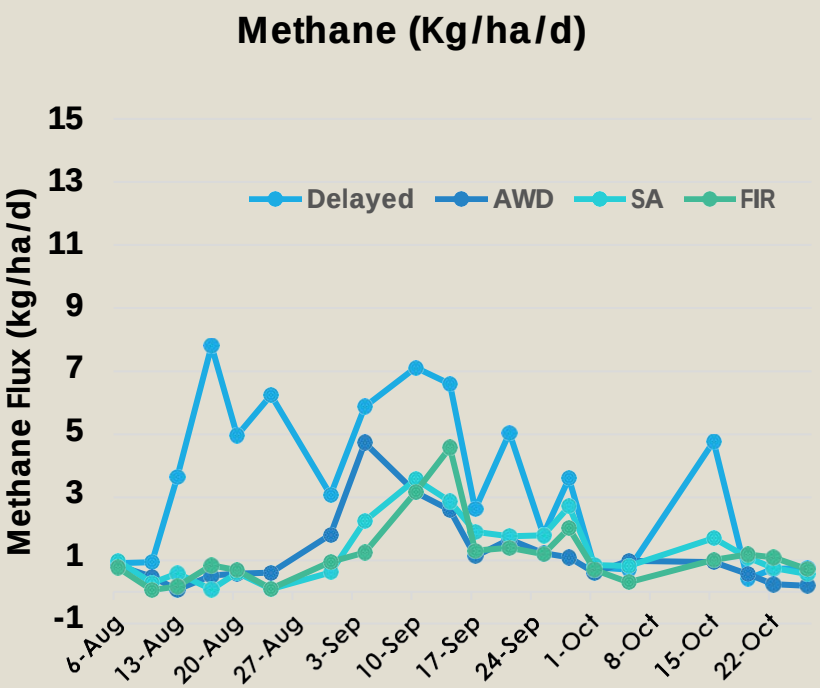
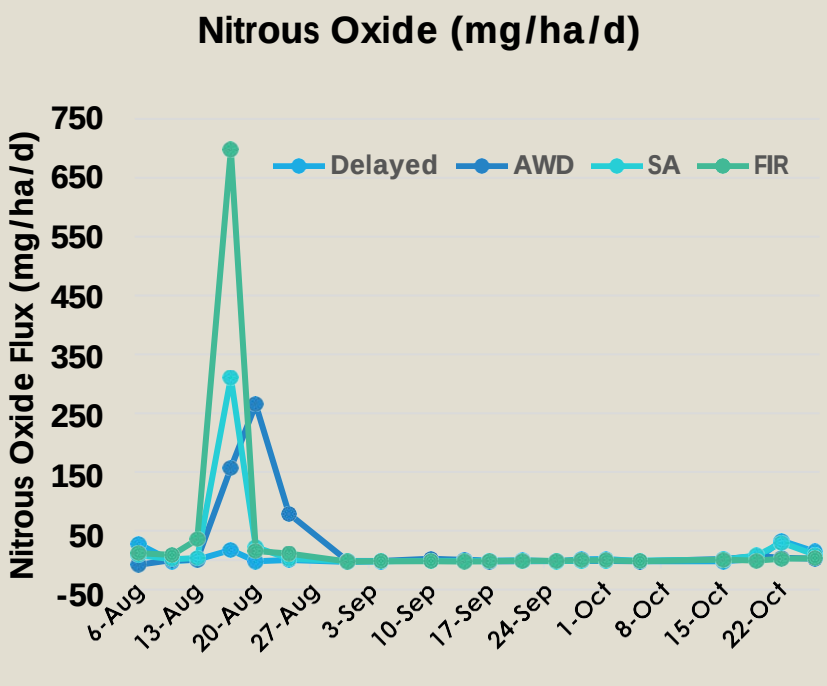
Methane Flux (kg/ha/d)
15
13
11
9
7
5
3
1
-1
Delayed
AWD
SA
FIR
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul
30-Jul
6-Aug

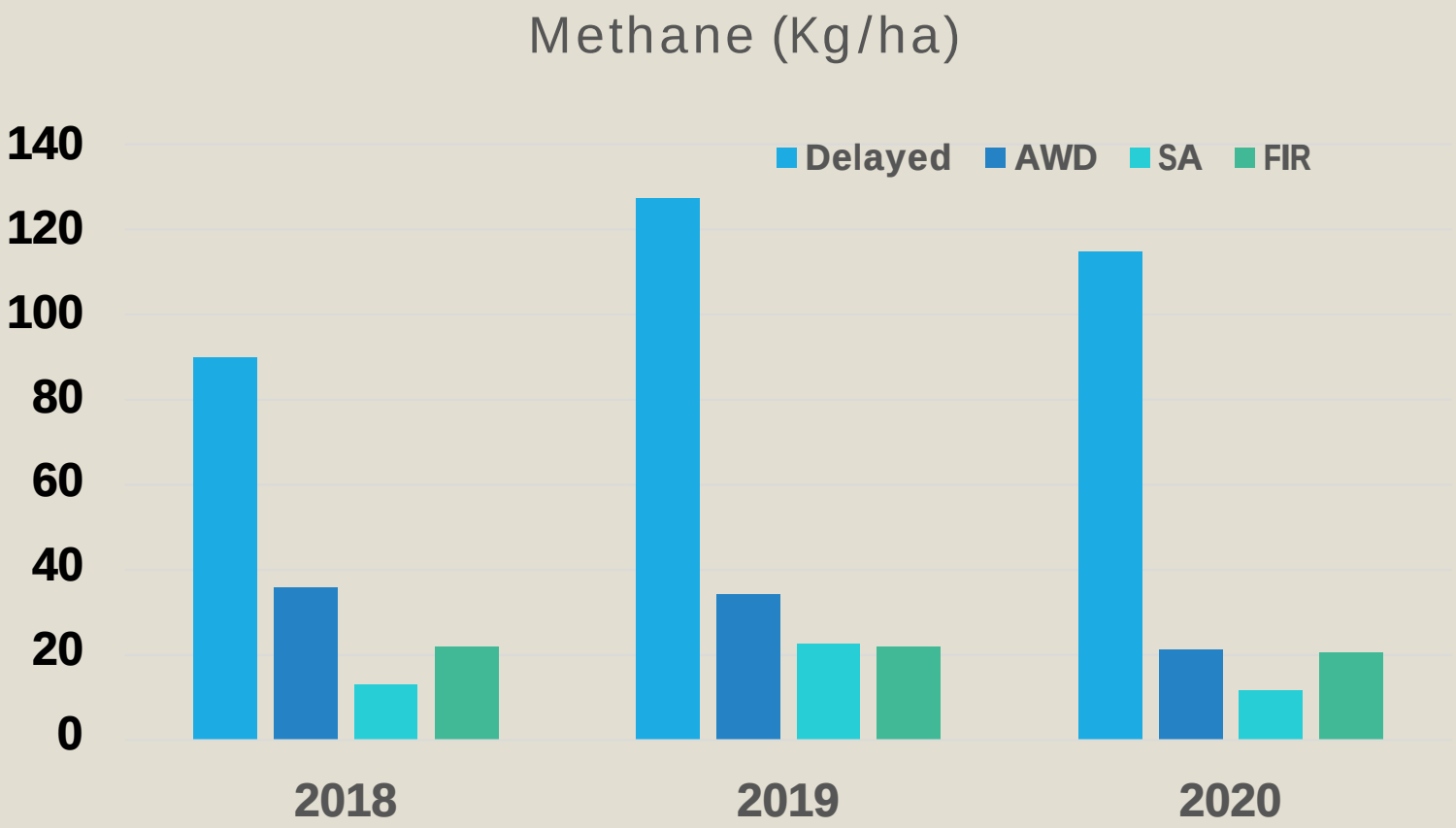

Nitrous Oxide (mg/ha/d)
Nitrous Oxide (mg/ha/d)
500
400
300
200
100
0
-100
Delayed
AWD
SA
FIR
28-May
4-Jun
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul
30-Jul
6-Aug

2020

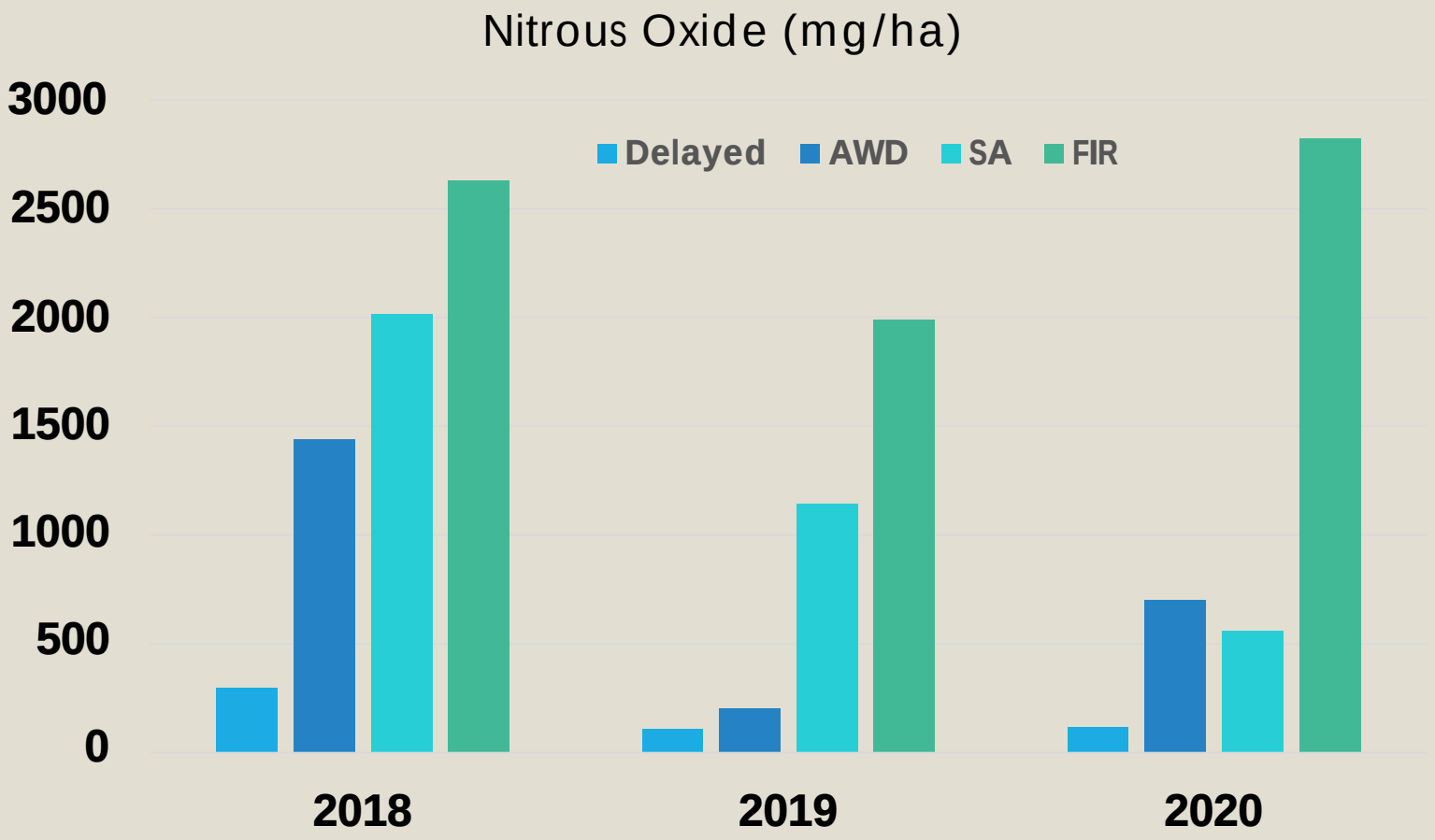

Methane (Kg/ha/d)
Methane Flux (kg/ha/d)
15
13
11
9
7
5
3
1
-1
Delayed
AWD
SA
FIR
6-Aug
13-Aug
20-Aug
27-Aug
3-Sep
10-Sep
17-Sep
24-Sep
1-Oct
8-Oct
15-Oct
22-Oct


Nitrous Oxide (mg/ha/d)
Nitrous Oxide Flux (mg/ha/d)
750
650
550
450
350
250
150
50
-50
Delayed
AWD
SA
FIR
6-Aug
13-Aug
20-Aug
27-Aug
3-Sep
10-Sep
17-Sep
24-Sep
1-Oct
8-Oct
15-Oct
22-Oct

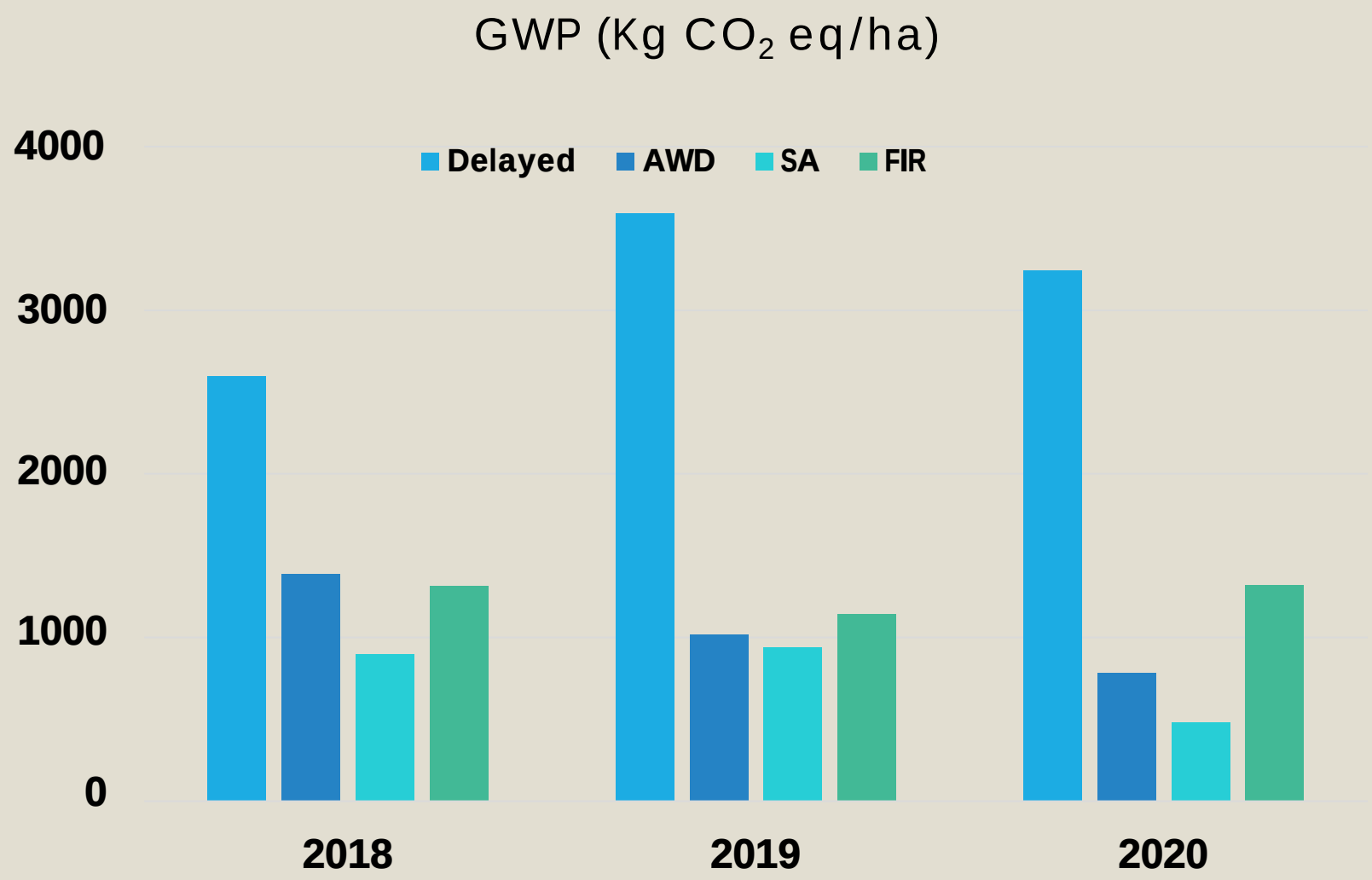
Season methane emissions



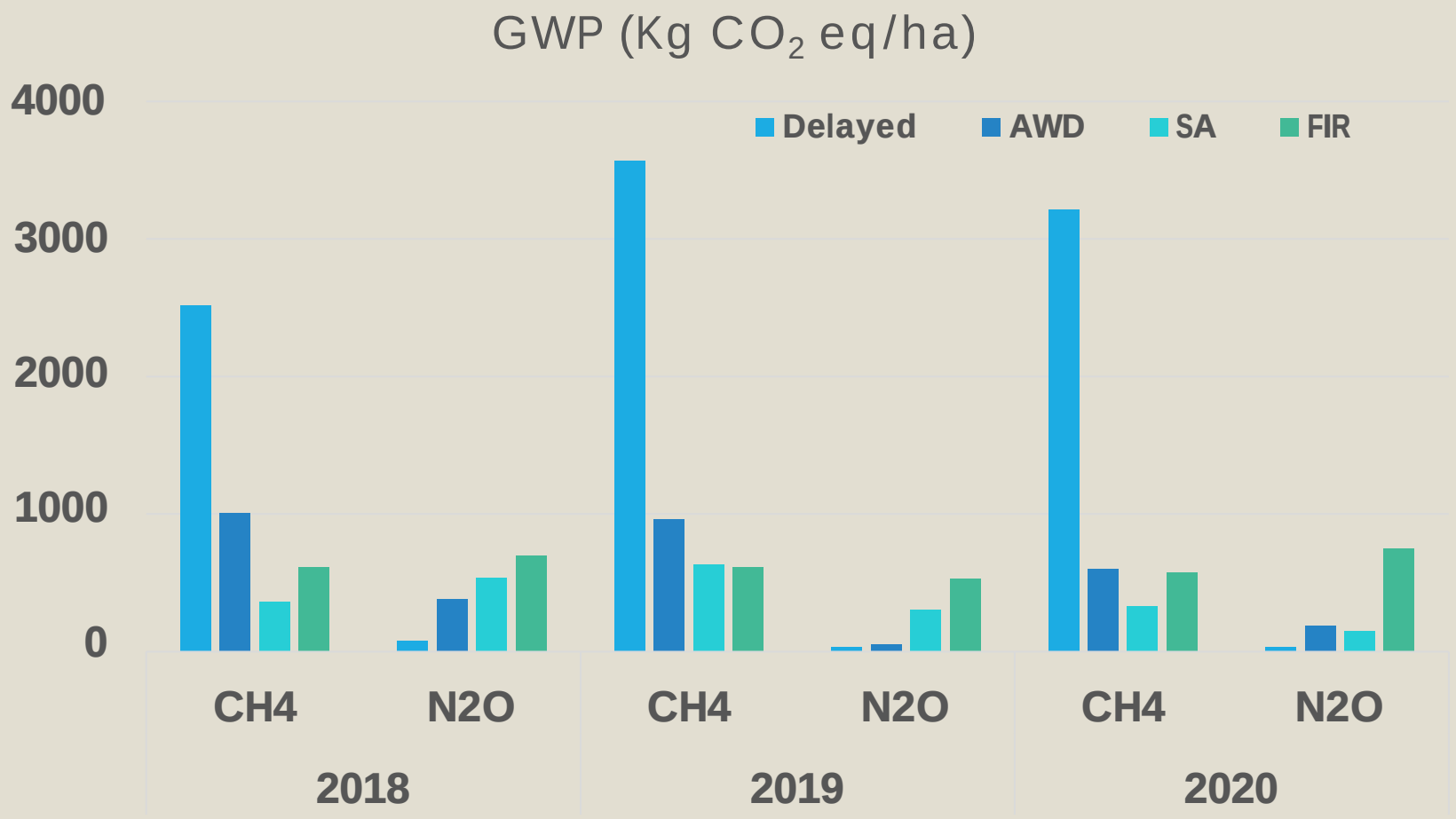
Season nitrous oxide emissions



GWP (Kg CO2 eq/ha : 100-year time horizon)



GWP from each gas



Conclusion

- Methane emission in delayed flood treatment was higher than the other water management practices
- The highest nitrous oxide emission was observed in FIR water treatment
- Both methane and nitrous oxide emissions were varied by years
- GWP was mainly distributed from methane

Thank you!