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SYSTEM PERFORMANCE & WATER PRODUCTIVITY OF DEFICIT IRRIGATED SUGAR CANE UNDER CENTRE PIVOT AT MWENEZANA ESTATES – S.E. LOWVELD, ZIMBABWE
ABOUT 20 000 HA (/150 000 HA) UNDER SUGAR CANE IRRIGATION IN ZIMBABWE
- Estates companies are subsidiaries of international companies – AAC & T-H.
- Various irrigation methods incl. Centre Pivot
- 150 000 Tonnes exported annually
- Forex earning for the country

SUGAR CANE ESTATES ARE LARGE CONSUMERS OF WATER AT BASIN LEVEL
- Sugar cane is a “water guzzler”
- How much is actually being consumed?
- How are systems actually performing?
INTRODUCTION & BACKGROUND

• MWENEZANA SUGAR ESTATES INTEREST IN RESEARCH:
  – PERFORMANCE OF CP SYSTEM
  – FERTIGATION
  – AUTOMATED IRRIGATION SCHEDULING

• WE EXPANDED ON:
  – SYSTEM PERFORMANCE
  – WATER PRODUCTIVITY

• ANOTHER DEPARTMENT WORKING ON:
  – IRRIGATION SCHEDULING
STUDY OBJECTIVES

• ASSESS:
  – THE TECHNICAL PERFORMANCE OF CP SYSTEMS AT MWENEZANA
  – WATER PRODUCTIVITY
    • RAW SUGAR
    • EXTRACTABLE RECOVERABLE CRYSTAL (ERC)
APPLICABLE INDICATORS

• **CP TECHNICAL PERFORMANCE:**
  – **UNIFORMITY COEFFICIENT** – $U_{HH}$
  – $U_{HH}$ MUCH MORE APPROPRIATE FOR CP

• **WATER USE:**
  – **TOTAL IRRIGATION WATER APPLIED** (ML/HA/YR)

• **FIELD LEVEL WATER PRODUCTIVITY:**
  – **WP CANE** = CANE YIELD / WATER APPLIED (I+Pe)
  – **WP ERC** = ERC YIELD / WATER APPLIED (I+Pe)
STUDY AREA (1)

- MWENEZANA SUGAR ESTATES
  - ALMOST 500 KM SOUTH OF HARARE
  - GRID REFERENCE 22.5° LT & 30.7° LN
  - SEMI-ARID REGION (NR V)
  - < 500 mm ANNUAL RAINFALL
  - HIGH EVAPORATION RATES >1 500 mm
STUDY AREA (2)
STUDY AREA (3)

- **ESTATE** IS IN 2 SECTIONS
  - SECTION 1 = 1012 HA
  - SECTION 2 = 976 HA
- **TOTAL IRRIGATION AREA** = 1 988 HA
  - 596 HA UNDER CP IRRIGATION
  - VALLEY® & AGRICO® CP SYSTEMS > 10 YRS OLD
- **SOILS**
  - SANDY LOAMS OVER REDDISH BROWN SANDY CLAY LOAMS
  - VARIABLE DEPTH, BUT >0.6 M
STUDY AREA (4)

• WATER SUPPLY
  – BY ZINWA FROM MANYUCHI DAM IN MZINGWANE CATCHMENT
  – RELEASED INTO MWENEZI RIVER & FLOWS FOR 40 KM
  – THEN ABSTRACTED BY 3 PUMPS (750 L/S EA.) INTO A 14 KM CANAL TO A BALANCING DAM ON ESTATE
  – FROM BALANCING DAM INTO THE 2 SECTIONS IN-FIELD DAMS & IRRIGATION
STUDY AREA (5)

• CROP MANAGEMENT
  – SUGAR CANE (VAR. NCo376, N14, ZN1L)
  – SEED CANE CUTTINGS TREATED WITH ANTI-FUNGAL
  – PRE-EMERGENCE HERBICIDE (FOR BOTH RATOON & PLANT CANE)
  – FERTILISERS
    • SSP – BEFORE EMERGENCE (200 & 400 KG/HA)
    • BASAL – DURING 1ST 10 WEEKS (DEP. ON SOIL TESTS)
    • TOP – 3 SPLITS APPLICATIONS (TOTAL 450 KG/HA)
STUDY AREA (6)

- **IRRIGATION**
  - IRRIGATED TO FIELD CAPACITY AFTER PLANTING
  - IRRIGATION SCHEDULING USES “PIN BOARD” METHOD BASED ON CROP, SOIL & CLIMATIC FACTORS FOR EACH FIELD
  - IRRIGATE AT 50% DEPLETION OF TAW
PERFORMANCE ASSESSMENT

• **STANDARD PROCEDURES**
  – AS PER ASABE ES 436
  – 34 CATCH CANS SPACED 12 M APART FOR A 50 HA SPAN
  – EVALUATED 10 CP MACHINES

• **NOTED ALSO:**
  – ACTUAL DISCHARGE
  – WETTED DIAMETER
  – OPERATING PRESSURE
  – TIME TO SWEEP PAST THE CATCH CANS
  – WIND DIRECTION
  – SPRINKLER DATA (MANUFACTURER)
DATA COLLECTION

• **MET. DATA** (1999 – 2005) – FOR DETERMINING P-effective

• **DAILY RECORDS OF IRRIGATION OFFTAKES** (1999 – 2005) – FOR TOTAL IRRIGATION WATER APPLIED (DISCHARGE/DURATION/IRR. DEPTH)

• **CANE YIELD [RAW CANE & ERC]** (1999 – 2005) FROM ESTATE RECORDS – FOR WP CALCULATIONS
RESULTS – CP SYSTEM PERFORMANCE

• UNIFORMITY COEFFICIENT $U_{HH}$
  – RANGED FROM 49.1% TO 55.2%
  – (VS. 79% TO 85% EXPECTED STD.)

• POSSIBLE CAUSES OF UNIFORMITY LOSS(?):
  – LEAKING GASKETS & JOINTS
  – LOW OPERATING PRESSURE (e.g., 130 kPa vs 300 kPa)
  – REDUCED MOBILITY FROM PLANTS COILED AROUND DRIVE SHAFTS
  – OBSTRUCTED NOZZLES
  – WHEEL ALIGNMENT(?)

RESULTS – WATER CONSUMPTION (1)
RESULTS – WATER CONSUMPTION (2)

- **WATER CONSUMPTION:**

- **MEAN YEAR LEVELS RANGED:**
  - COMPARE WITH 15 MI/HA/YR
RESULTS – WP CANE (1)
RESULTS – WP CANE (2)

![Graph showing water productivity of cane (kg/m³) over years from 1999 to 2004 for different groups: I, G1-G4, G5-G8, H1-H4, H5-H8. The graph illustrates fluctuations in productivity across the years.]
RESULTS – WP CANE (3)

- MEAN WP (YR. AVGS.) RANGED: 7.68 – 11.13 KG/M³
  - COMPARE WITH 13.3 KG/M³ (AUSTRALIA) & 23.5 KG/M³ (USA)
- WP CANE FIGURES DROPPED IN 1999/2000 – PROBABLY DUE TO CYCLONE ELINE
RESULTS – WP ERC (1)

• WP ERC TREND FOLLOWED WP CANE

• AVERAGE WP ERC (YR. AVGS) RANGED 0.98 TO 1.54 KG/M³
  – COMPARE WITH 1.4 KG/M³
CONCLUSION & RECOMMENDATION (1)

• CP SYSTEM PERFORMANCE BELOW EXPECTED LEVEL

• NEED:
  – CP SYSTEM REPAIRS & MAINTENANCE
  – CP SYSTEM MONITORING
  – ADEQUATE OPERATING PRESSURE
CONCLUSION & RECOMMENDATION (2)

- WATER USEAGE LEVELS COMPARABLE TO EXPECTATIONS
- WP VALUES A BIT ON THE LOWER SIDE
- NEED:
  - INCREASE YIELDS THROUGH BETTER CROP MANAGEMENT
  - EVEN BETTER IRRIGATION SCHEDULING
THANK YOU