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Testing sowing rules and estimating best sowing dates for crop simulations in GYGA

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September 2015

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Old approach: fixed sowing dates

- Actual sowing dates collected per buffer zone by country agronomists
- Crop growth simulations used the actual sowing date per buffer zones
- Used actual sowing date was fixed over the years
- Hence, inter-annual rainfall variation had no effect on the simulated sowing dates per year

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Actions to derive improved sowing dates

- Collecting sowing windows per buffer zones by country agronomists
- Analysing the effectiveness of different sowing rules to derive year specific sowing dates, focus on Burkina Faso
- Based on Burkina Faso results:
  - Applied to GYGA countries the best sowing rule to derive year specific sowing dates within the sowing window for the crop growth simulations

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Analysing the effectiveness of different sowing rules in Burkina Faso

- We tested methods for deriving optimal sowing dates
- Optimal sowing date is the date that results in the highest simulated rainfed yields and lowest yield variation
- Model analyses were done for different sowing dates and rules
- Modelling was done for maize and sorghum and for three locations in north, central and south Burkina Faso with strong differences in precipitation

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Approach for analysing sowing rule effectiveness

- Crop modelling was done with the WOFOST model for both maize and sorghum in Burkina Faso
- Historical weather data over 15 years from Dori (476 mm), Ouagadougou (714 mm) and Bobo Dioulasso (1028 mm mean rainfall) were used
- Growth duration and actual sowing dates per location and variety were used as supplied by country agronomist
- Estimated mean values of soil characteristic for the crop simulations: effective rooting depth = 100cm, available moisture fractions = 10% and runoff fraction= 10%

Testing sowing dates and sowing rules

Testing was done for ten crop variety – location combinations :

Location	Crop variety [1]	Fixed optimal (Fix) sowing date IDSOW for model calibration and application (Julian day)	Growth duration (days)	Optimized (Opt) sowing date as based on crop growth modelling (Julian day)
Dori	Sorghum short	182	80	182
Dori	Sorghum long	182	100	172
Ouagadougou	Maize short	174	90	194
Ouagadougou	Maize long	174	110	184
Ouagadougou	Sorghum short	174	90	174
Ouagadougou	Sorghum long	174	110	174
Bobo-Dioulasso	Maize short	166	90	186
Bobo-Dioulasso	Maize long	166	110	166
Bobo-Dioulasso	Sorghum short	166	90	156
Bobo-Dioulasso	Sorghum long	166	110	156

[1] short= short duration crop variety, long= long duration crop variety

Tested sowing dates and rules → Variants

- Variant Fix → fixed optimal sowing date (IDSOW) as based on country agronomist estimates
- Variant Opt → highest simulated yields from simulations for optimal sowing date -30 to + 40 days
- Sowing rules with

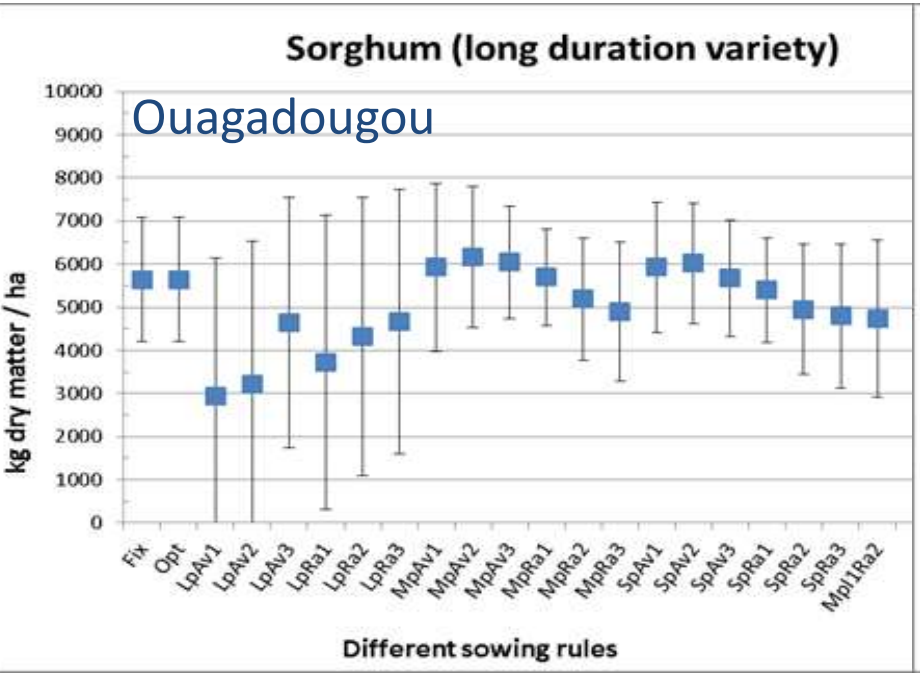
1) cumulative rainfall (**Ra**) ≥ 2.0, 3.0 or 4.0 cm, or

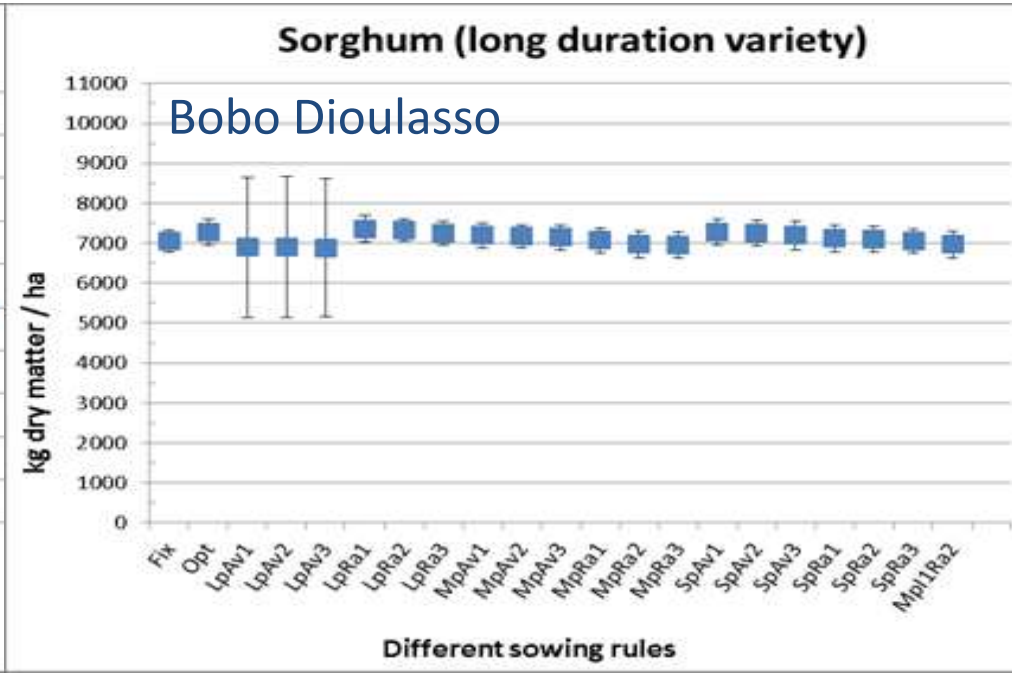
2) available soil moisture (**Av**) > 1.0, 2.0 or 3.0 cm,

and 3) sowing window between Julian days 136-212, 160-200 or IDSOW -10 to IDSOW+10 (i.e. **Lp, Mp or Sp**)

Results from sowing rule analysis (1)

Clear Interaction between the climate zone and the precision required for the sowing date or rule: lower precision required in Bobo Dioulasso

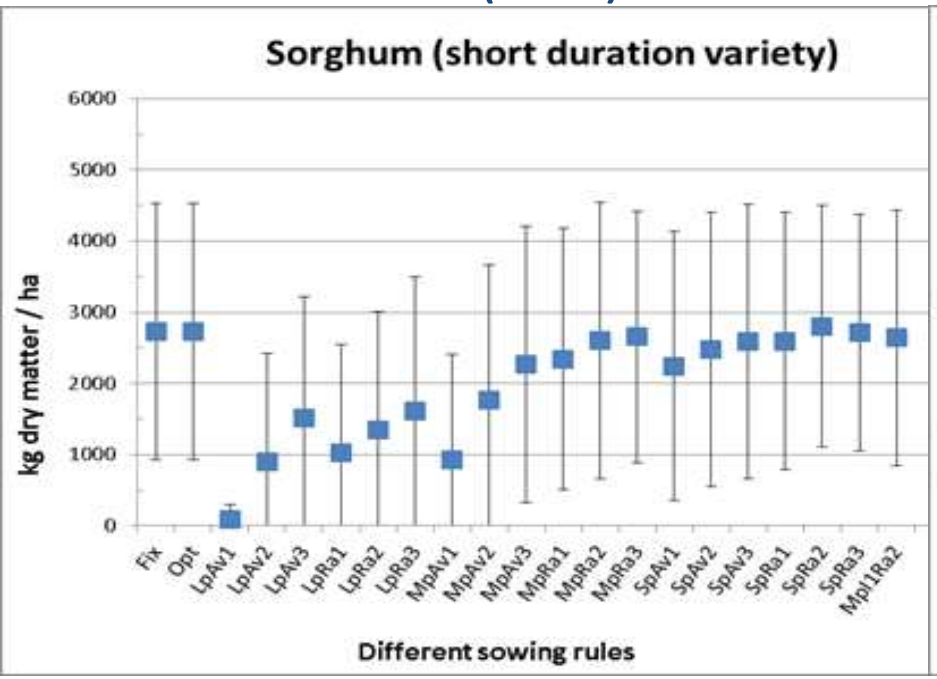


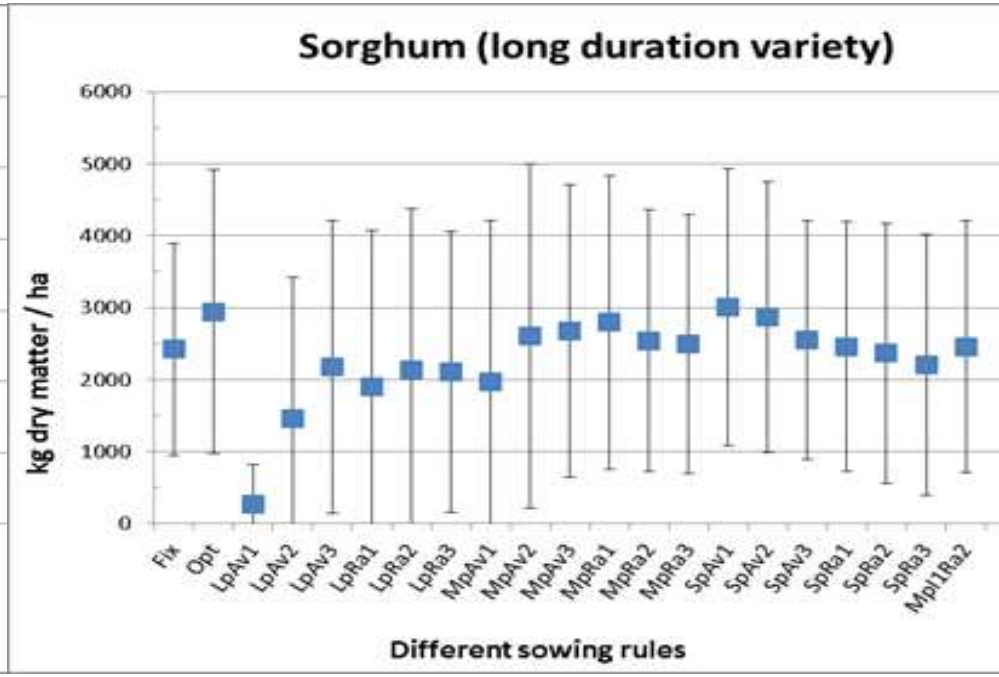


Mean and SD of simulated sorghum grain yields for the period 1990-2004 for different sowing date and rules

Results from sowing rule analysis (2)

Some interaction between the growth duration and the best sowing rule or date in Dori, Burkina Faso: yield of long duration variety is best at earlier sowing date and thus with lower rainfall criteria (Ra1)

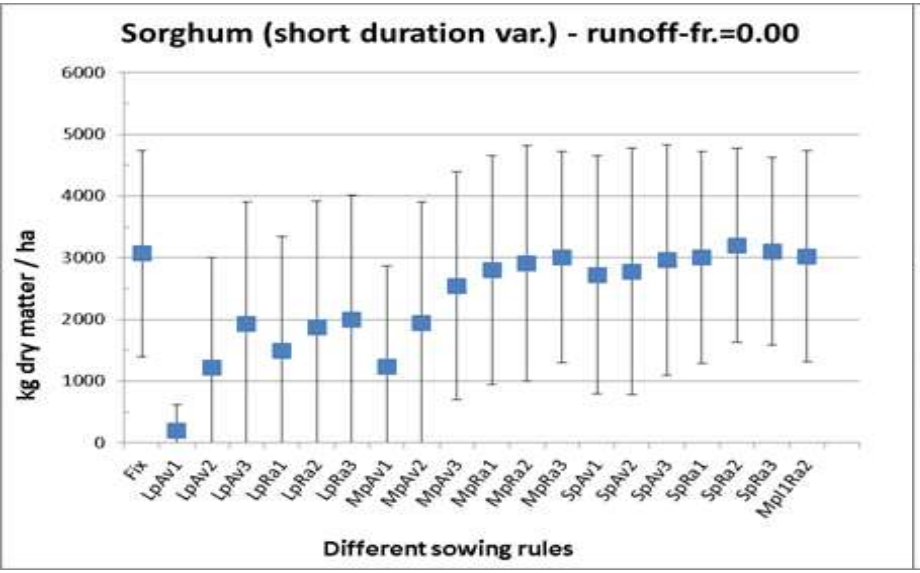


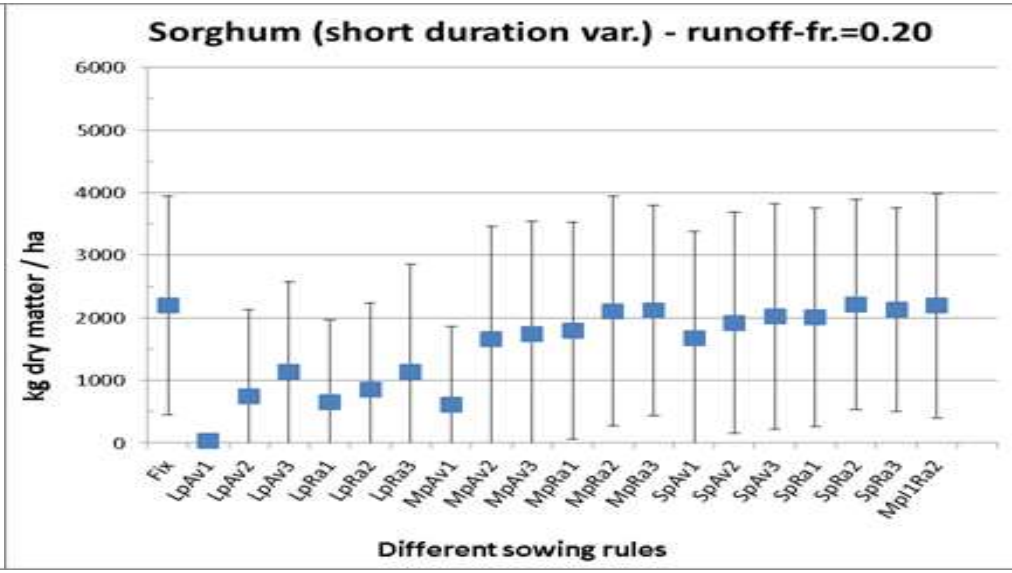


Mean and SD of simulated sorghum grain yields for the period 1990-2004 at Dori, for different sowing date and rule variants

Results from sowing rule analysis (3)

Strong effects of differences in surface runoff losses on yields, but not on the selected best sowing date or rule: highest yield in Dori for lowest runoff fraction

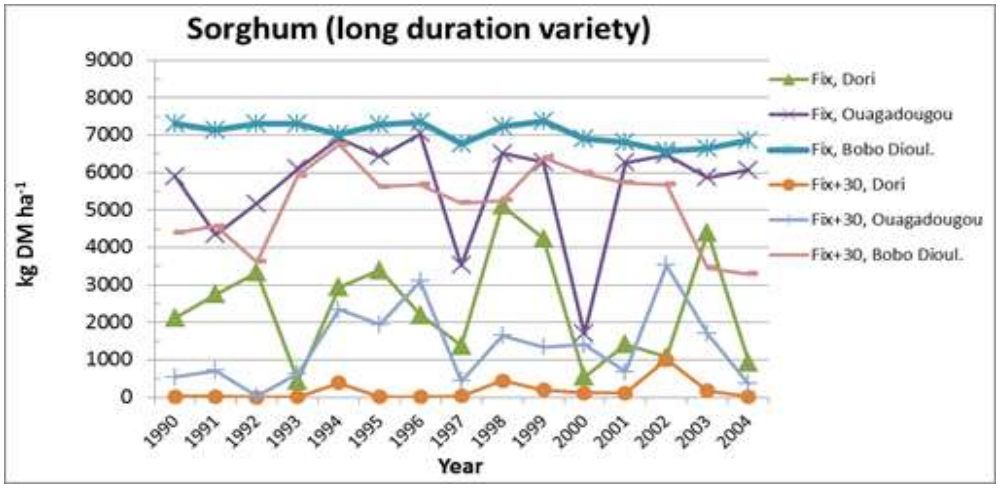




Mean and SD of simulated grain yields of sorghum for the period 1990-2004 at Dori with surface runoff fraction set to 0% (**left**) and 20% (**right**) for different sowing date and rule variants

Results from sowing rule analysis (4)

Strong effect from delaying the sowing date by 30 days which mimics the effect of non-mechanized (versus mechanized) farming: strong yield reductions and particularly in north-central Burkina (i.e. Dori and Ouagadougou)



Simulated grain yields of sorghum over a period of 15 years at respectively, Dori, Ouagadougou and Bobo Dioulasso for the fixed optimal sowing date (i.e. Fix) and for the fixed optimal sowing date plus 30 days of delay (i.e. Fix+30)

Main conclusions from sowing rule analysis for Burkina Faso

- Sorghum should be sown best between Julian days 160 and 200
- Best criteria for sorghum in the dry northern part of Burkina Faso :

  - long duration sorghum variety to be sown when cumulative rainfall is ≥2 cm in sowing window

  - short duration sorghum variety to be sown later when cumulative rainfall is ≥3 cm

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Main conclusions from sowing rule analysis for Burkina Faso

- Best criteria for sorghum in the central part of Burkina Faso:

  - sowing should start when cumulative rainfall in this period is ≥2 cm or

  - when available soil moisture content is >1 cm

- Sowing date rules are generally crop and location specific for Burkina

- Required precision of the sowing rules appears to rapidly decrease with increasing duration and intensity of the rainy season

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More information about this Sowing rule study

See:

Sowing rules for estimating rainfed yield potential of sorghum and maize in Burkina Faso by J. Wolf, K. Ouattara, & I. Supit, 2015

Agricultural and Forest Meteorology vol. 214–215, p. 208–218

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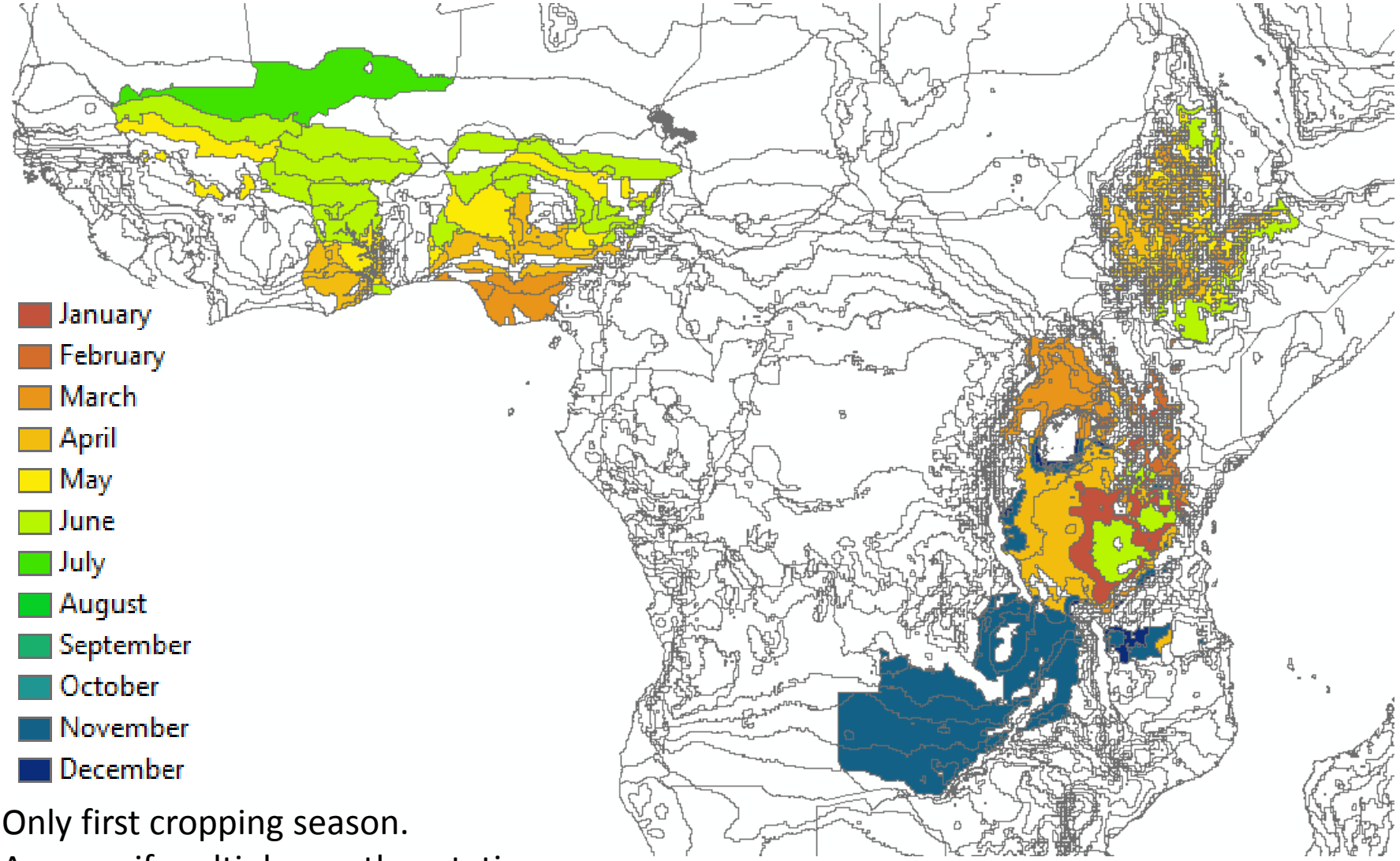
Sowing date simulation for GYGA

Based on results from Burkina Faso:

- Optimal sowing window should be 1 – 1.5 month
- Most simple and stable sowing: amount of cumulative rainfall
- Criteria applied to derive sowing dates for all buffer zones in the ten African GYGA countries: ≥ 2.0 cm of rainfall within one week within the sowing window
- The derived yearly varying sowing dates appear to result in reliable crop simulations, except for zones where sowing windows and rainfall patterns do not correspond well

Start sowing window per climate zone



Only first cropping season.
Average if multiple weather stations are located in climate zone

Conclusions about replacement of fixed sowing date by sowing rule

- Use of a sowing rule in crop simulations results in yearly variable sowing dates and thus in a better adaptation to the year-specific rainfall patterns
- Use of a sowing rule is assumed to better mimic the yearly variation in sowing dates per location in the real farming situation and thus, to improve the correspondence between the simulated and actual growing conditions and crop yields

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Conclusions about replacement of fixed sowing date by sowing rule

- The precision of the derived sowing dates from such rule appeared to be strongly dependent on the used sowing window which is dependent on local expert knowledge

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Thank you for your attention and for your contribution!

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