# **ONLINE APPENDIX 1 (“UNEVEN COTTON OUTCOMES....”)**

### **A.1.1. Cotton output at the colony level, 1900–1959**

***Criteria of country inclusion:*** I include countries for which I found evidence of colonial investments and/or coercive efforts to bolster cotton production and stimulate export during the period from 1900 to 1959. These efforts include experimenting with cotton varieties, establishing ginneries, and instructing or forcing cultivators to grow cotton. This criterion yields a sample of 21 countries. Next, I exclude Ghana and Sierra Leone, where attempts to establish a cotton sector were brief and quickly abandoned (Dumett 1975; Richards 1983). I include the British-Egyptian Sudan (Bernal 1995) but note that a large proportion of cotton there was grown under irrigated conditions in the *Gezira Scheme* at the confluence of the Blue and White Nile, and therefore not subject to the local rainfall regime. The same was true for Mali where, in light of sustained rejection by African farmers to expand production, most cotton was grown at the *Office du Niger* along the Niger river (Roberts 1996; Van Beusekom 2002). I exclude South Africa, Basutoland, and Swaziland because of their very different (non-tropical) climate, and South Africa’s non-colonial status for most of the period. Alongside Mali and Sudan, I include the following countries (listing one or multiple references to the existence of serious and persistent colonial cotton projects): Angola (Pitcher 1993), Benin (Manning 1990), Burkina Faso (Cordell & Gregory 1982), Burundi (Leurquin 1963), Cameroon (Austen and Headrick 1983:60), Central African Republic (Suchel 1967), Chad (Kassambara 2010), Belgian Congo (Likaka 1997), Côte d’Ivoire (Bassett 2001), Kenya (Fearn 1961), Malawi (Mandala 1990), Mali (Roberts 1996), Mozambique (Isaacman 1996), Nigeria (Hinds 1996; Hogendorn 1995; Vincent 1976), Togo (Maier 1995), Uganda (Wrigley 1959), Tanzania (Austen 1968; Monson 1995; Sunseri 2001), and Zimbabwe (Nyambara 2000).

***Cotton output in metric tons***: I estimate country-level output based on the series provided in Mitchell (1993, p. 244-45), supplemented with additional data for Angola (Pitcher 1993, p. 283); Dahomey/Benin (Manning 1990), Burundi (*Verslag van het Belgisch Bestuur van Ruanda-Urundi* various years), Chad (Cabot 1965, p. 186) Belgian Congo (Likaka 1997, p. 42), Côte d’Ivoire (Bassett 2001, p. 52), Kenya (Fearn 1961, p. 73), Mali (Roberts 1996), Malawi (Frankema, Woltjer and Williamson 2018), Mozambique (*Anuário Estatístico, Colónia de Moçambique* various years; Bravo 1963, p. 81), Oubangi-Chari/Central African Republic (Suchel 1967, p. 411) and Togo (*Tableau Général du Commerce Extérieur* various years).

### **A.1.2. Rainfall zones and cotton output (input for Table 1)**

 **Map 1.** Rainfed cotton output in 1957 **Map 2.** Rainy months per year 

 **Map 3.** Population density  **Map 4.** Cotton yield potential 

*Notes:* Present-day borders are shown for orientation. Diagonally crossed countries are excluded (see footnote 1 in the main text). Cotton output from the Soudan (*Office du Niger*) and the Anglo-Egyptian Sudan (the *Gezira Scheme* and other irrigation projects) has been excluded, since it was not generated under rainfed conditions (94.8 percent of cotton from these two countries was produced in areas with 2 or less wet months per year) and hence not dependent on the rainfall seasonality regime. In map 2, every ‘rainfall zone’ (Table 1) has a different shade of grey. Map 1, 3 and 4 have been scaled following the original sources.

*Sources:* Cotton output from Hance, Kotschar & Peterec (1961), population from Klein Goldwijk et al. (2017), length of the rainy season from Matsuura & Willmott (2015), and cotton suitability (maximum feasible output per hectare) from FAO/IISA (2011).

### **A.1.3.** Correlation of colony-level cotton output in Figure 1 versus Hance et al. 1961.

# **ONLINE APPENDIX 2 (“LABOR SEASONALITY AND COTTON OUTPUT: A SIMULATION”)**

### **A.2.1.** Stylized farm parameters

|  |  |  |
| --- | --- | --- |
| **HOUSEHOLD** |  |  |
| ***Value*** | ***Description*** | ***Source*** | ***Related 'step'***  |
| 5 | Family size (two adults, three children) | *See text* | *2* |
| 1.6 | Maximum adult male equivalent labor units per day | *See text* | *1* |
| 312 | Annual working days per adult male equivalent | *See text* | *none\** |
| 2100 | Caloric requirements per capita per day | *See text* | *2* |
| 3832500 | Caloric requirements per family per year | *Calculation* | *2* |
| *Notes: \*This information is used in the subsection "Wage labor and migration" of the section "Repercussions of..."*  |
|  |  |  |  |
| **FOOD CROPS (MILLET)** |  |  |
| ***Value*** | ***Description*** | ***Source*** | ***Related 'step'***  |
| 25% | 'Normal surplus' to account for partial harvest failure | *See text* | *2* |
| 4790625 | Required caloric output per family per year | *Calculation* | *3* |
| 606 | Yield (kilogram per hectare) | *See text* | *3* |
| 3417 | Caloric value (calories per kilogram) | *See text* | *3* |
| 2070702 | Caloric yield (calories per hectare) | *Calculation* | *3* |
| 2.31 | Required food crop hectares per family per year | *Calculation* | *3* |
| 99 | Required labor inputs (man-days per hectare per year) | *See text* | *3* |
| 229 | Required labor inputs for self-sufficiency (man-days per year) | *Calculation* | *3* |
| 600 | Pre-1960 yield, Côte d'Ivoire | *See text* | *4* |
| 1000 | 1980s yield, Côte d'Ivoire | *See text* | *4* |
| 0.60 | Adjustment of harvest labor input to pre-1960 conditions | *Calculation* | *4* |
|  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **COTTON** |   |  |  |
| ***Value*** | ***Description*** | ***Source*** | ***Related 'step'***  |
| 198 | Required labor inputs (man-days per hectare per year) | *See text* | *3* |
| 2 | Assumed picking efficiency gain, FWA | *See text* | *4* |
| 4 | Yield gain, 1960–1980, FWA | *See text* | *4* |
| 0.50 | Adjustment of harvest labor input to pre-1960 conditions | *Calculation* | *4* |
|  |  |  |  |
| **POSTCOLONIAL 'BREAKTHROUGH' CONDITIONS IN FWA** |  |  |
| ***Value*** | ***Description*** | ***Source*** | ***Related 'step'***  |
| 1212 | Food crop yield (kilogram per hectare) | *See text* | *none\** |
| 4141404 | Caloric value (calories per kilogram) | *Calculation* | *none\** |
| 1.16 | Required food crop hectares per family per year | *Calculation* | *none\** |
| 49.5 | Food crop required labor inputs (man-days per hectare per year) | *Calculation* | *none\** |
| 57.3 | Required labor inputs for self-sufficiency (man-days per year) | *Calculation* | *none\** |
| 300 | Pre-1960 yield per hectare | *See text* | *none\** |
| 1200 | Post-1960 yield per hectare | *See text* | *none\** |
| 99 | Cotton required labor inputs (man-days per hectare per year) | *See text* | *none\** |
| *Notes: \*This information is used in the section "Overcoming seasonality in French West Africa"* |  |

### **A.2.2.** Seasonality calculations in FWA

|  |
| --- |
| **a. Original data on monthly labor distribution for cotton and food crops (related to 'step' 4)** |
| *Katiali 1981–1982 (Bassett 2001, p. 126): values express total number of days per household*  |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton | 5 | 4 | 8 | 17 | 11 | 22 | 21 | 23 | 8 | 18 | 28 | 1 |
| Food crops | 0 | 0 | 1 | 11 | 22 | 41 | 46 | 57 | 54 | 37 | 10 | 30 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| **b. Harvest-adjusted monthly labor distribution for cotton and food crops (related to 'step' 4)** |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton | 5 | 4 | 8 | 17 | 11 | 22 | 21 | 23 | 8 | **9** | **14** | 1 |
| Food crops | 0 | 0 | 1 | 11 | 22 | 41 | 46 | 57 | 54 | 37 | 10 | **18** |
| *Notes: Cotton was harvested in October and November, millet was harvested in December* |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **c. Conversion into monthly shares of the annual total per crop (related to 'step' 4 and shown in Figure 4)**  |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton | 3% | 3% | 6% | 12% | 8% | 15% | 15% | 16% | 6% | 6% | 10% | 1% |
| Food crops | 0% | 0% | 0% | 4% | 7% | 14% | 15% | 19% | 18% | 12% | 3% | 6% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **d. Monthly labor requirements (man-days) for food crop cultivation to achieve household self-sufficiency (related to 'step' 5)** |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Food crops | 0.0 | 0.0 | 0.8 | 8.5 | 17.0 | 31.6 | 35.5 | 44.0 | 41.6 | 28.5 | 7.7 | 13.9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **e. Monthly labor (man-days) remaining for cotton cultivation (related to 'step' 5)**  |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Days in month | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| Total available | 49.6 | 44.8 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 |
| Remaining for cotton  | 49.6 | 44.8 | 48.8 | 39.5 | 32.6 | 16.4 | 14.1 | 5.6 | 6.4 | 21.1 | 40.3 | 35.7 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **f. Monthly labor requirements (man-days) for cotton cultivation, per hectare (related to 'step' 5)**  |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Labor per hectare | 6.9 | 5.5 | 11.1 | 23.5 | 15.2 | 30.5 | 29.1 | 31.8 | 11.1 | 12.5 | 19.4 | 1.4 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **g. Cotton production possibilities (hectare) (related to 'step' 5)** |
| *FWA* |  |  |  |  |  |  |  |  |  |  |  |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Max hectares | 7.16 | 8.09 | 4.41 | 1.68 | 2.14 | **0.54** | **0.49** | **0.18** | 0.57 | 1.69 | 2.08 | 25.80 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **h. Three most constraining months (result of 'step' 5)** |  |  |  |  |  |  |  |  |  |
|   |  |  |   |  |  |  |  |  |  |  |  |  |
| Min | 2nd\_Min | 3rd\_Min | Average\_Min |  |  |  |  |  |  |  |  |  |
| 0.18 | 0.49 | 0.54 | **0.40** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **i. Final daily labor inputs (related to 'step' 5 and shown in Figure 5)**  |
| *FWA* |   |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Food crops | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 | 1.1 | 1.1 | 1.4 | 1.4 | 0.9 | 0.3 | 0.4 |
| Cotton | 0.1 | 0.1 | 0.1 | 0.3 | 0.2 | 0.4 | 0.4 | 0.4 | 0.1 | 0.2 | 0.3 | 0.0 |
| Maximum labor capacity | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| Rainfall (right axis) | 7 | 15 | 57 | 96 | 148 | 153 | 209 | 298 | 267 | 123 | 39 | 13 |
| *Notes: Rainfall is taken from Figure 3*  |

### **A.2.3.** Seasonality calculations in Uganda

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| --- |
| **a. Original data on monthly labor distribution for cotton and food crops (related to 'step' 4)**  |
| *Aboke, Lango, 1964–1965 (Cleave 1974, p. 87): values express share of total monthly labor inputs in the peak month (July)*  |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 85 | 32 | 6 | 17 | 38 | 49 | 65 | 53 | 52 | 39 | 38 | 66 |
| First-season food crops | 2 | 4 | 43 | 33 | 29 | 17 | 15 | 3 | 2 | 2 | 2 | 2 |
| Second-season food crops | 3 | 0 | 3 | 4 | 8 | 9 | 20 | 32 | 24 | 19 | 22 | 19 |
| *Notes: Millet relabeled 'first season'; 'other food crops' relabeled 'second season'* |   |   |   |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| *Koro, Acholi, 1964–1965 (Cleave 1974, p. 87): values express share of total monthly labor inputs in the peak month (July)*  |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 79 | 33 | 8 | 7 | 57 | 58 | 56 | 60 | 51 | 36 | 25 | 52 |
| First-season food crops | 0 | 7 | 18 | 34 | 17 | 6 | 21 | 4 | 2 | 2 | 2 | 2 |
| Second-season food crops | 9 | 3 | 6 | 7 | 9 | 15 | 23 | 28 | 22 | 21 | 25 | 17 |
| *Notes: Millet relabeled 'first season'; 'other food crops' relabeled 'second season'* |   |   |   |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| *Teso, c. 1970 (Vail 1977, p. 104): values express total man-hours expanded on 9.2-acre farm* |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 82 | 20 | 27 | 57 | 79 | 139 | 181 | 143 | 86 | 155 | 139 | 96 |
| First-season food crops | 22 | 56 | 159 | 122 | 125 | 162 | 69 | 39 | 0 | 0 | 0 | 0 |
| Second-season food crops | 5 | 4 | 0 | 0 | 0 | 3 | 5 | 13 | 23 | 6 | 23 | 4 |
| *Notes: millet, groundnut Jan–Jun relabeled 'first season'; sorghum, sweet potato relabeled 'second season'. Non-seasonal cassava omitted*  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **b. Harvest-adjusted monthly labor distribution for cotton and food crops (related to 'step' 4)**  |
| *Aboke, Lango* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 16% | 6% | 1% | 3% | 7% | 9% | 12% | 10% | 10% | 7% | 7% | 12% |
| First-season food crops | 1% | 3% | 28% | 21% | 19% | 11% | 10% | 2% | 1% | 1% | 1% | 1% |
| Second-season food crops | 2% | 0% | 2% | 2% | 5% | 6% | 12% | 20% | 15% | 12% | 13% | 12% |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| *Koro, Acholi* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 15% | 6% | 2% | 1% | 11% | 11% | 11% | 11% | 10% | 7% | 5% | 10% |
| First-season food crops | 0% | 6% | 16% | 30% | 15% | 5% | 18% | 3% | 2% | 2% | 2% | 2% |
| Second-season food crops | 5% | 2% | 3% | 4% | 5% | 8% | 12% | 15% | 12% | 11% | 14% | 9% |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| *Teso* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 7% | 2% | 2% | 5% | 7% | 12% | 15% | 12% | 7% | 13% | 12% | 8% |
| First-season food crops | 3% | 7% | 21% | 16% | 17% | 21% | 9% | 5% | 0% | 0% | 0% | 0% |
| Second-season food crops | 6% | 5% | 0% | 0% | 0% | 3% | 6% | 15% | 27% | 7% | 27% | 5% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **c. Conversion into monthly shares of the annual total per crop (related to 'step' 4 and shown in Figure 4)**  |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cotton |   | 13% | 5% | 2% | 3% | 8% | 11% | 13% | 11% | 9% | 9% | 8% | 10% |
| First-season food crops | 1% | 5% | 22% | 22% | 17% | 13% | 12% | 4% | 1% | 1% | 1% | 1% |
| Second-season food crops | 4% | 2% | 2% | 2% | 3% | 6% | 10% | 17% | 18% | 10% | 18% | 8% |
| *Notes: I take the simple arithmetic average of the three available samples, which were taken in adjacent cotton-growing districts.*  |

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| **d. Monthly labor requirements (man-days) for food crop cultivation to achieve household self-sufficiency (related to 'step' 5)**  |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| First-season food crops | 3.2 | 12.3 | 49.4 | 51.3 | 38.3 | 28.8 | 28.4 | 8.1 | 2.3 | 2.3 | 2.3 | 2.3 |
| Second-season food crops | 9.6 | 4.8 | 3.9 | 4.8 | 7.5 | 13.1 | 23.3 | 38.1 | 40.7 | 22.9 | 41.0 | 19.5 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| First-season share | Second-season share |   |   |   |   |   |   |   |   |   |   |   |   |
| 80% | 20% | 4.5 | 10.8 | 40.3 | 42.0 | 32.1 | 25.7 | 27.4 | 14.1 | 10.0 | 6.4 | 10.1 | 5.7 |
| 70% | 30% | 5.1 | 10.0 | 35.7 | 37.3 | 29.1 | 24.1 | 26.8 | 17.1 | 13.8 | 8.5 | 13.9 | 7.5 |
| 65% | 35% | 5.4 | 9.7 | 33.4 | 35.0 | 27.5 | 23.3 | 26.6 | 18.6 | 15.8 | 9.5 | 15.9 | 8.3 |
| 64% | 36% | 5.5 | 9.6 | 33.0 | 34.5 | 27.2 | 23.1 | 26.5 | 18.9 | 16.2 | 9.7 | 16.3 | 8.5 |
| 63% | 37% | 5.6 | 9.5 | 32.5 | 34.1 | 26.9 | 23.0 | 26.5 | 19.2 | 16.5 | 9.9 | 16.6 | 8.7 |
| 62% | 38% | 5.6 | 9.4 | 32.1 | 33.6 | 26.6 | 22.8 | 26.4 | 19.5 | 16.9 | 10.1 | 17.0 | 8.8 |
| 61% | 39% | 5.7 | 9.4 | 31.6 | 33.1 | 26.3 | 22.7 | 26.4 | 19.8 | 17.3 | 10.3 | 17.4 | 9.0 |
| 60% | 40% | 5.8 | 9.3 | 31.2 | 32.7 | 26.0 | 22.5 | 26.3 | 20.1 | 17.7 | 10.5 | 17.8 | 9.2 |
| 59% | 41% | 5.8 | 9.2 | 30.7 | 32.2 | 25.7 | 22.4 | 26.3 | 20.4 | 18.1 | 10.8 | 18.2 | 9.3 |
| 58% | 42% | 5.9 | 9.1 | 30.3 | 31.7 | 25.4 | 22.2 | 26.2 | 20.7 | 18.5 | 11.0 | 18.6 | 9.5 |
| 57% | 43% | 5.9 | 9.1 | 29.8 | 31.3 | 25.1 | 22.0 | 26.2 | 21.0 | 18.8 | 11.2 | 19.0 | 9.7 |
| 56% | 44% | 6.0 | 9.0 | 29.4 | 30.8 | 24.7 | 21.9 | 26.1 | 21.3 | 19.2 | 11.4 | 19.4 | 9.9 |
| 55% | 45% | 6.1 | 8.9 | 28.9 | 30.3 | 24.4 | 21.7 | 26.1 | 21.6 | 19.6 | 11.6 | 19.7 | 10.0 |
| 50% | 50% | 6.4 | 8.5 | 26.6 | 28.0 | 22.9 | 20.9 | 25.8 | 23.1 | 21.5 | 12.6 | 21.7 | 10.9 |
| 40% | 60% | 7.0 | 7.8 | 22.1 | 23.4 | 19.8 | 19.4 | 25.3 | 26.1 | 25.4 | 14.7 | 25.6 | 12.6 |
| 30% | 70% | 7.7 | 7.0 | 17.5 | 18.7 | 16.7 | 17.8 | 24.8 | 29.1 | 29.2 | 16.7 | 29.4 | 14.3 |
| *Notes: e. and g. are used to manually calibrate the first/second season shares to maximize cotton production*  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| **e. Monthly labor (man-days) remaining for cotton cultivation (related to 'step' 5)**  |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Days in month |   | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| Total available |   | 49.6 | 44.8 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| First-season share | Second-season share |  |  |  |  |  |  |  |  |  |  |  |  |
| 80% | 20% | 45.1 | 34.0 | 9.3 | 6.0 | 17.5 | 22.3 | 22.2 | 35.5 | 38.0 | 43.2 | 37.9 | 43.9 |
| 70% | 30% | 44.5 | 34.8 | 13.9 | 10.7 | 20.5 | 23.9 | 22.8 | 32.5 | 34.2 | 41.1 | 34.1 | 42.1 |
| 65% | 35% | 44.2 | 35.1 | 16.2 | 13.0 | 22.1 | 24.7 | 23.0 | 31.0 | 32.2 | 40.1 | 32.1 | 41.3 |
| 64% | 36% | 44.1 | 35.2 | 16.6 | 13.5 | 22.4 | 24.9 | 23.1 | 30.7 | 31.8 | 39.9 | 31.7 | 41.1 |
| 63% | 37% | 44.0 | 35.3 | 17.1 | 13.9 | 22.7 | 25.0 | 23.1 | 30.4 | 31.5 | 39.7 | 31.4 | 40.9 |
| 62% | 38% | 44.0 | 35.4 | 17.5 | 14.4 | 23.0 | 25.2 | 23.2 | 30.1 | 31.1 | 39.5 | 31.0 | 40.8 |
| 61% | 39% | 43.9 | 35.4 | 18.0 | 14.9 | 23.3 | 25.3 | 23.2 | 29.8 | 30.7 | 39.3 | 30.6 | 40.6 |
| 60% | 40% | 43.8 | 35.5 | 18.4 | 15.3 | 23.6 | 25.5 | 23.3 | 29.5 | 30.3 | 39.1 | 30.2 | 40.4 |
| 59% | 41% | 43.8 | 35.6 | 18.9 | 15.8 | 23.9 | 25.6 | 23.3 | 29.2 | 29.9 | 38.8 | 29.8 | 40.3 |
| 58% | 42% | 43.7 | 35.7 | 19.3 | 16.3 | 24.2 | 25.8 | 23.4 | 28.9 | 29.5 | 38.6 | 29.4 | 40.1 |
| 57% | 43% | 43.7 | 35.7 | 19.8 | 16.7 | 24.5 | 26.0 | 23.4 | 28.6 | 29.2 | 38.4 | 29.0 | 39.9 |
| 56% | 44% | 43.6 | 35.8 | 20.2 | 17.2 | 24.9 | 26.1 | 23.5 | 28.3 | 28.8 | 38.2 | 28.6 | 39.7 |
| 55% | 45% | 43.5 | 35.9 | 20.7 | 17.7 | 25.2 | 26.3 | 23.5 | 28.0 | 28.4 | 38.0 | 28.3 | 39.6 |
| 50% | 50% | 43.2 | 36.3 | 23.0 | 20.0 | 26.7 | 27.1 | 23.8 | 26.5 | 26.5 | 37.0 | 26.3 | 38.7 |
| 40% | 60% | 42.6 | 37.0 | 27.5 | 24.6 | 29.8 | 28.6 | 24.3 | 23.5 | 22.6 | 34.9 | 22.4 | 37.0 |
| 30% | 70% | 41.9 | 37.8 | 32.1 | 29.3 | 32.9 | 30.2 | 24.8 | 20.5 | 18.8 | 32.9 | 18.6 | 35.3 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **f. Monthly labor requirements (man-days) for cotton cultivation, per hectare (related to 'step' 5)**  |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Labor requirements/hectare | 24.9 | 9.2 | 3.2 | 6.1 | 16.2 | 20.9 | 24.9 | 21.9 | 17.5 | 17.8 | 15.4 | 19.9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **g. Cotton production possibilities (hectare) (related to 'step' 5)**  |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
| First-season share | Second-season share | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 80% | 20% | 1.81 | 3.70 | 2.89 | 0.99 | 1.08 | 1.07 | 0.89 | 1.62 | 2.17 | 2.42 | 2.46 | 2.20 |
| 70% | 30% | 1.79 | 3.79 | 4.30 | 1.75 | 1.27 | 1.14 | 0.91 | 1.48 | 1.95 | 2.31 | 2.21 | 2.12 |
| 65% | 35% | 1.78 | 3.83 | 5.01 | 2.14 | 1.36 | 1.18 | 0.92 | 1.42 | 1.84 | 2.25 | 2.08 | 2.07 |
| 64% | 36% | 1.77 | 3.83 | 5.15 | 2.21 | 1.38 | 1.19 | 0.92 | 1.40 | 1.82 | 2.24 | 2.06 | 2.07 |
| 63% | 37% | 1.77 | 3.84 | 5.29 | 2.29 | 1.40 | **1.19** | **0.93** | **1.39** | 1.80 | 2.23 | 2.03 | 2.06 |
| 62% | 38% | 1.77 | 3.85 | 5.43 | 2.36 | 1.42 | 1.20 | 0.93 | 1.37 | 1.77 | 2.22 | 2.01 | 2.05 |
| 61% | 39% | 1.77 | 3.86 | 5.57 | 2.44 | 1.44 | 1.21 | 0.93 | 1.36 | 1.75 | 2.20 | 1.98 | 2.04 |
| 60% | 40% | 1.76 | 3.87 | 5.71 | 2.52 | 1.46 | 1.22 | 0.93 | 1.35 | 1.73 | 2.19 | 1.96 | 2.03 |
| 59% | 41% | 1.76 | 3.88 | 5.86 | 2.59 | 1.48 | 1.22 | 0.93 | 1.33 | 1.71 | 2.18 | 1.93 | 2.02 |
| 58% | 42% | 1.76 | 3.88 | 6.00 | 2.67 | 1.50 | 1.23 | 0.94 | 1.32 | 1.69 | 2.17 | 1.91 | 2.01 |
| 57% | 43% | 1.76 | 3.89 | 6.14 | 2.75 | 1.52 | 1.24 | 0.94 | 1.31 | 1.66 | 2.16 | 1.88 | 2.01 |
| 56% | 44% | 1.75 | 3.90 | 6.28 | 2.82 | 1.54 | 1.25 | 0.94 | 1.29 | 1.64 | 2.15 | 1.86 | 2.00 |
| 55% | 45% | 1.75 | 3.91 | 6.42 | 2.90 | 1.56 | 1.25 | 0.94 | 1.28 | 1.62 | 2.13 | 1.83 | 1.99 |
| 50% | 50% | 1.74 | 3.95 | 7.12 | 3.28 | 1.65 | 1.29 | 0.95 | 1.21 | 1.51 | 2.08 | 1.71 | 1.94 |
| 40% | 60% | 1.71 | 4.03 | 8.54 | 4.05 | 1.84 | 1.37 | 0.97 | 1.07 | 1.29 | 1.96 | 1.46 | 1.86 |
| 30% | 70% | 1.69 | 4.11 | 9.95 | 4.81 | 2.03 | 1.44 | 0.99 | 0.94 | 1.07 | 1.85 | 1.20 | 1.77 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **h. Three most constraining months (result of 'step' 5)** |  |  |  |  |  |  |  |  |  |  |
| First-season share | Second-season share | Min | 2nd\_Min | 3rd\_Min | Average |  |  |  |  |  |  |  |  |  |  |
| 80% | 20% | 0.89 | 0.99 | 1.07 | **0.982** |  |  |  |  |  |  |  |  |  |  |
| 70% | 30% | 0.91 | 1.14 | 1.27 | **1.108** |  |  |  |  |  |  |  |  |  |  |
| 65% | 35% | 0.92 | 1.18 | 1.36 | **1.155** |  |  |  |  |  |  |  |  |  |  |
| 64% | 36% | 0.92 | 1.19 | 1.38 | **1.165** |  |  |  |  |  |  |  |  |  |  |
| 63% | 37% | 0.93 | 1.19 | 1.39 | **1.170** |  |  |  |  |  |  |  |  |  |  |
| 62% | 38% | 0.93 | 1.20 | 1.37 | **1.168** |  |  |  |  |  |  |  |  |  |  |
| 61% | 39% | 0.93 | 1.21 | 1.36 | **1.167** |  |  |  |  |  |  |  |  |  |  |
| 60% | 40% | 0.93 | 1.22 | 1.35 | **1.166** |  |  |  |  |  |  |  |  |  |  |
| 59% | 41% | 0.93 | 1.22 | 1.33 | **1.164** |  |  |  |  |  |  |  |  |  |  |
| 58% | 42% | 0.94 | 1.23 | 1.32 | **1.163** |  |  |  |  |  |  |  |  |  |  |
| 57% | 43% | 0.94 | 1.24 | 1.31 | **1.161** |  |  |  |  |  |  |  |  |  |  |
| 56% | 44% | 0.94 | 1.247 | 1.29 | **1.160** |  |  |  |  |  |  |  |  |  |  |
| 55% | 45% | 0.94 | 1.254 | 1.28 | **1.159** |  |  |  |  |  |  |  |  |  |  |
| 50% | 50% | 0.95 | 1.21 | 1.29 | **1.152** |  |  |  |  |  |  |  |  |  |  |
| 40% | 60% | 0.97 | 1.07 | 1.29 | **1.113** |  |  |  |  |  |  |  |  |  |  |
| 30% | 70% | 0.94 | 0.99 | 1.07 | **1.001** |  |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| **i. Final daily labor inputs (related to 'step' 5 and shown in Figure 5)** |
| *Uganda* |  |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Food crops (first season) | 0.1 | 0.3 | 1.0 | 1.1 | 0.8 | 0.6 | 0.6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Food crops (second season) | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.5 | 0.3 | 0.5 | 0.2 |
| Cotton |   | 0.9 | 0.4 | 0.1 | 0.2 | 0.6 | 0.8 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.8 |
| Maximum labor capacity | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| Rainfall (right axis) | 23 | 43 | 88 | 168 | 185 | 116 | 129 | 207 | 154 | 138 | 81 | 42 |
| *Notes: Rainfall is taken from Figure 3* |

### **A.2.4.** Seasonality calculations in FWA, post-productivity breakthrough

|  |
| --- |
| **a. to c. Identical to FWA\_seasonality (A.2.2. above)**  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **d. Monthly labor requirements (man-days) for food crop cultivation to achieve household self-sufficiency** |
| *Côte d'Ivoire* |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Food crops | 0.0 | 0.0 | 0.2 | 2.1 | 4.2 | 7.9 | 8.9 | 11.0 | 10.4 | 7.1 | 1.9 | 3.5 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **e. Monthly labor (man-days) remaining for cotton cultivation**  |
| *Côte d'Ivoire* |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Days in month | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| Total available | 49.6 | 44.8 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 | 49.6 | 48.0 | 49.6 | 48.0 | 49.6 |
| Remaining for cotton  | 49.6 | 44.8 | 49.4 | 45.9 | 45.4 | 40.1 | 40.7 | 38.6 | 37.6 | 42.5 | 46.1 | 46.1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **f. Monthly labor requirements (man-days) for cotton cultivation, per hectare**  |
| *Côte d'Ivoire* |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Labor requirements/hectare | 3.5 | 2.8 | 5.5 | 11.8 | 7.6 | 15.2 | 14.5 | 15.9 | 5.5 | 6.2 | 9.7 | 0.7 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **g. Cotton production possibilities (hectare)**  |
| *Côte d'Ivoire* |   |   |   |   |   |   |   |   |   |   |   |
|   | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Max hectares  | 14.33 | 16.18 | 8.92 | 3.90 | 5.96 | **2.63** | **2.80** | **2.42** | 6.79 | 6.82 | 4.75 | 66.63 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **h. Three most constraining months** |  |  |  |  |  |  |  |  |  |
| Min | 2nd\_Min | 3rd\_Min | Average\_Min |  |  |  |  |  |  |  |  |  |
| 2.42 | 2.63 | 2.80 | **2.62** |  |  |  |  |  |  |  |  |  |

### **A.2.5.** Results of simulation

|  |
| --- |
| **COTTON PRODUCTION CAPACITY** |
| 1.17 | Uganda (hectare) |
| 0.40 | Côte d'Ivoire (hectare) |
|  |  |
| **LABOR REMAINING FOR NON-AGRICULTURAL WORK** |
| 499 | Working days per household for non-reproductive work |
| 308 | Working days per household for agricultural work, Côte d'Ivoire |
| 461 | Working days per household for agricultural work, Uganda |
| 191 | Working days remaining for non-agricultural, non-reproductive work, Côte d'Ivoire |
| 39 | Working days remaining for non-agricultural, non-reproductive work, Uganda |
| 62% | Productive agricultural labor as share of total capacity, Côte d'Ivoire |
| 92% | Productive agricultural labor as share of total capacity, Uganda |
|  |  |
| **COTTON PRODUCTION CAPACITY IN FWA AFTER PRODUCTIVITY BREAKTHROUGH** |
| 2.62 | Cotton production capacity, Côte d'Ivoire (hectare) |
| 6.54 | #-fold increase of hectare cultivation capacity since colonial era |
| 26.18 | #-fold increase of cotton production capacity since colonial era |

# **ONLINE APPENDIX 3 (“FOOD YIELDS AND COTTON PLANTING IN UGANDA: A PANEL ANALYSIS”)**

### **A.3.1.** Robustness specifications (alternative shock cut-offs and falsification tests)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Dependent variable:**Log of cotton acreage* | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS |
| Rainfall deviation(Jan.–Apr.) |  |  |  |  |  | –0.075\*\*\* |  |  |  |
|  |  |  |  |  | (0.020) |  |  |  |
| Lagged rainfall deviation(Jan.–Apr.) |  |  |  |  | –0.038 |  |  |  |  |
|  |  |  |  | (0.030) |  |  |  |  |
| Lead rainfall deviation |  |  |  |  |  |  | 0.008 |  |  |
| (Jan.–Apr.) |  |  |  |  |  |  | (0.024) |  |  |
| Rainfall deviation(May–Aug.) |  |  |  |  | –0.000 |  | –0.008 |  |  |
|  |  |  |  | (0.026) |  | (0.026) |  |  |
| Lagged rainfall deviation(May–Aug.) |  |  |  |  |  | –0.037 | –0.039 |  |  |
|  |  |  |  |  | (0.027) | (0.029) |  |  |
| Rainfall deviation(Sep.–Dec.) |  |  |  |  | –0.035 |  |  |  |  |
|  |  |  |  | (0.026) |  |  |  |  |
| Lagged rainfall deviation(Sep.–Dec.) |  |  |  |  |  | 0.009 |  |  |  |
|  |  |  |  |  | (0.027) |  |  |  |
| Excessive rain shock(Jan.–Apr.) | –0.051 | –0.138\*\* | –0.080 | –0.183\* |  |  |  |  |  |
| (0.054) | (0.054) | (0.054) | (0.084) |  |  |  |  |  |
| Drought shock(Jan.–Apr.) | –0.051 | –0.043 | –0.072\*\* | –0.235\*\*\* |  |  |  |  |  |
| (0.039) | (0.131) | (0.026) | (0.069) |  |  |  |  |  |
| Rainfall deviation |  |  |  |  |  |  |  | –0.008 |  |
| (Jan.–Dec.) |  |  |  |  |  |  |  | (0.038) |  |
| Non-absolute linear rainfall deviation |  |  |  |  |  |  |  |  | –0.012 |
| (Jan.–Apr.) |  |  |  |  |  |  |  |  | (0.021) |
| District & year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| District-specific effects | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| No. of observations | 357 | 357 | 347 | 347 | 338 | 339 | 338 | 353 | 357 |
| No. of districts | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

*Notes:* Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### **A.3.2.** Replication of Table 3 showing wild bootstrapped p- and t-values of significant variables only.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Dependent variable:**Log of cotton acreage* | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS |
| Rainfall deviation(Jan.–Apr.) | 0.030 | 0.014 | 0.015 | 0.053 | 0.007 | 0.002 | 0.040 | 0.089 |  |  |
| (–2.672) | (–2.972) | (–3.065) | (–2.343) | (–3.786) | (–2.944) | (–2.100) | (–2.056) |  |  |
| Rainfall deviation(May–Aug.) |  |  |  |  | 0.090 |  |  |  |  |  |
|  |  |  |  | (–1.902) |  |  |  |  |  |
| Rainfall deviation(Sep.–Dec.) |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Excessive rain shock(Jan.–Apr.) |  |  |  |  |  |  |  |  | –0.045 | –0.057 |
|  |  |  |  |  |  |  |  | (–2.315) | (–2.110) |
| Drought shock(Jan.–Apr.) |  |  |  |  |  |  |  |  |  | 0.031 |
|  |  |  |  |  |  |  |  |  | (–2.651) |
| District & year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| District-specific effects | N | Y | Y | Y | N | Y | Y | Y | Y | Y |
| No. of observations | 357 | 357 | 353 | 283 | 343 | 326 | 324 | 340 | 357 | 347 |
| No. of districts | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

*Notes:* t-statistics are given in parentheses. Results were produced using the “boottest” command in Stata computing 999 replications.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### **A.3.3. Rainfall stations**

The rainfall stations for each of the respective spatial units are located in Gulu (Acholi district), Mbarara (Ankole district), Masindi (Bunyoro district), Namasagali (Busoga district), Mbale (Central district), Lira (Lango district), Masaka (Masaka district), Entebbe (Mengo district), Ngora (Teso district), Fort Portal (Toro-Mubende cotton zone), and Arua (West Nile district). Data for 1925–1930 were obtained from meteorological tables in the annual colonial *Blue Books* (Uganda Protectorate, *Blue Book for the year...*). Data for 1931–1960 were obtained from Meteorological Department (1965), for 1961 and 1962 from Uganda Protectorate, *Annual Reports of Agriculture for the year...*

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