PARAMETERS	VALUE	DETAILS	REFERENCES
SETUP			
AGRICULTURAL RADIUS	30 patches (3 km)	Modern indigenous groups rarely travel more than several kilometres to farm land (Apaza et al., 2002; Ringhofer, 2010). The mounds are, on average, spaced 2.69 km from their nearest neighbour (Lombardo and Prümers, 2010).	(Apaza et al., 2002; Lombardo and Prümers, 2010; Ringhofer, 2010)
DEATH AGE	30 timesteps (years)	Represents the age at which a nuclear household (parents + children) ceases to exist (dissolves). Assumed to be 30 timesteps (years) as nuclear family units form and raise families, followed by children ageing and starting new households. Similar to the Artificial Anasazi model (Axtell et al., 2002) in that the average length varies with a mean of 30-year duration.	(Axtell et al., 2002)
FISHING RADIUS	70 patches (7 km)	Beckerman (1987) suggests a 14 km maximum day trip. This is supported by distances covered by indigenous groups in Binford (2001:Table 7.10).	(Beckerman, 1987; Binford, 2001)
FORAGING RADIUS	70 patches (7 km)	Beckerman (1987) suggests a 14 km maximum day trip. This is supported by distances covered by indigenous groups in Binford (2001:Table 7.10).	(Beckerman, 1987; Binford, 2001)
HOUSEHOLDS-PER-MOUND	30 (150 people)	Prior to Hirst et al., 2025, no published estimates for the population of the Casarabe Culture were available. The general estimates for the size of Amazonia's population prior to European contact are highly variable (see Koch et al., 2019). Historical European accounts document villages of several hundred people in the region (see Denevan 1966). Our estimate (150 people per settlement) produces a population size of 6750 people for the northeastern quadrant (extrapolated to an overall MMR population	(Denevan, 1966; Hirst et al., 2025; Koch et al., 2019)

		of approximately 16,000 people). This is a density of 4.5km-2, much higher than the modern population density, and within the range calculated in Hirst et al. (2025).	
SIMULATION DURATION	1000 Timesteps (1000 years)	Matches current known length of occupation for Loma Salvatierra and Loma Mendoza in Jaimes Betancourt (2012, 2015).	Jaimes Betancourt (2012; 2015)
CONVERT-LAND			
FISHING MODIFIER	15%	Reflects the proportion of dietary protein obtain from aquatic animals. Estimates are within the range for contemporary Amazonian hunter-gatherers described in Binford:2001 Table 5.01. These represent estimates of 'dependence' on aquatic animals as a component of the diet. Slider incorporated so that multiple estimates can be tested in future work.	(Binford, 2001)
FORAGE DEMAND	109.5 kg household-1	The Tsimane indigenous community at Campo Bello consumed 109.5 kg of foraged arboreal crops per household per year (Ringhofer, 2010).	(Ringhofer, 2010)
FUELWOOD-DEMAND	3500 kg household-1	Ringhofer (2010) observed that 700 kg Fuelwood was extracted per person by the Tsimane. This indicates each household consumes 1.92 kg of fuelwood person-1 day-1, within the expected 1-2 kg expected range from across the tropics (Wood and Baldwin, 1985). This is also corroborated with the FAO (1983b) estimates of 0.78-1 m3 yr-1 estimates for Amazonia, as well as Latin America (FAO, 1983c). To compare, we assume the standard density for tropical hardwood of 700-900 kg m-3 (FAO, 1983a).	(Ringhofer, 2010; Wood and Baldwin, 1985; FAO 1983a,b,c)

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HUNTING MODIFIER	15%	Reflects the dietary portion of protein obtained from terrestrial animals. Estimates are within the range for contemporary Amazonian hunter-gatherers described in Binford (2001: Table 5.01). These represent estimates of 'dependence' on terrestrial animals as a component of diet. Slider incorporated so that multiple estimates can be tested in future work.	(Binford, 2001)

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MAIZE DEMAND	845 kg household -1	The demand for maize was estimated based on calorific demand, using body mass and physical activity levels obtained from the WHO (1985). Also see data from the National Research council (1989:Table 3-1). Adult consumption rates were based on the 18-30 year-old age bracket and weights of 62 and 56 kg for Males/Females respectively (based on the Tsimane; Gurven et al., 2013): (15.3 * 62) + 679 = 1627.6 kcal 〖day〗 ^(-1) [MALE] (14.7 * 56) + 496 = 1319.2 kcal 〖day〗 ^(-1) [FEMALE] Child consumption was calculated according to half the average adult weight, based on consumption for 3-10 year olds: (22.7 * 29.5) + 495 = 1164.65 kcal 〖day〗 ^(-1) [MALE] (22.5 * 29.5) + 499 = 1162.75 kcal 〖day〗 ^(-1) [FEMALE] These estimates were further increased to account for physical activity (National Research Council, 1989:Table 3-3). We assumed moderate activity by averaging the sedentary and highly active estimates, obtaining a ratio of 1.8125: Adult Male 2950.21 kcal day-1 Female 2391.05 kcal day-1 Child Male 2109.75 kcal day-1 Female 2107.48 kcal day-1 We assume 2/3ds is provided by maize (Kennet et al., 2020; Hermenegildo et al., 2024). Maize calorific content was based on Nuss and Tanumihardjo (2010).	(Gurven et al., 2013; Hermenegildo et al., 2024; Kennett et al., 2020; National Research Council, 1989; Nuss and Tanumihardjo, 2010; WHO, 1985

		kcal day-1	Maize (g day-1)
Adults	Male	1966.61	539
	Female	1593.87	437
	Average	1780.24	488
Child	Male	1406.46	385
	Female	1404.85	385
	Average	1405.61	385

This produces a final value of:

		kg year-1
Adults	Male	196.74
	Female	159.51
	Average	178.12
Children	Male	140.51
	Female	140.51
	Average	140.51

MAX AGE TO REACTIVATE FALLOW	15 timesteps (years)	For the Tsimane, recultivated secondary plots span from 1-15 years (Ringhofer, 2010). 15 years aligns with Woody pioneers appearing within 8 years and secondary forest structure establishing within two decades (Pena-Claros, 2003; Poorter et al., 2021)	(Pena-Claros, 2003; Poorter et al., 2021; Ringhofer, 2010)
OVERPRODUCTION MOD	20%	The additional maize that households choose to produce above general needs to account for shocks/additional tribute etc.	-
PALM-DEMAND	113.6 leaves household -1	A single Motacu palm leaf is estimated to weigh 3 kg (Ringhofer, pers. comm.). Each Tsimane roof requires 300 leaves and lasted approximated 4 years (Ringhofer, 2010). This was related to the proportion of leaves used in construction to estimate 113.6 leaves per household.	(Ringhofer, 2010)
PATCHES MODIFIED PER TIMESTEP	1-2	Small-scale farmers are only able to clear 3 ha of land using family labour (Fearnside, 1980). However, this is with modern metal tools which were not available prior to contact. We know that land clearance would have been much more difficult with stone equivalents (Denevan, 1992). We thus assume family could clear up to 1 ha of forest and up to 2 ha of savanna during the dry season	(Denevan, 1992; Fearnside, 1980)
PERCENT-PATCHES-CONSIDERED	3.60%	Households are able to choose from a percentage of the patches within the given radius when choosing new locations to farm. The key controlling factor over the amount of patches agents may select from is time for the model to run. We allow agents to select from 3.6% of patches within their agricultural radius. This equates to 100 patches within a 3 km radius of their settlement.	-

PROBABILITY OF REACTIVATION	67%	Households have a choice whether to select new land or reactivate an existing plot in their territory, implemented as a slider shifting from 0-100%. We assume in all scenarios that a mix of these two occur, but that this mix can vary significantly. Ringhofer estimates farmers prefer reactivating land at a 2:1 ratio (2010).	(Ringhofer, 2010)
PROTEIN-DEMAND	78.34 kg household-1	WHO (1985) estimates a 'safe' level of intake is 0.75 g kg-1. The average weight of a Tsimane adult is 59 kg (Gurven et al. 2013). From this we estimate that each adult requires 44.25 g day-1. Each child is estimated based on 50% of their adult weight, but require more protein per kg (0.99-1.86 g kg-1). They are estimated for 42.04 g day-1.	(Gurven et al., 2013; WHO, 1989)
RESOURCES			
FISH-DENSITY	4	Aside from marbled swamp eel and catfish, there is little information around the densities of fish within the Llanos de Moxos. The only available estimates come from small ponds during the dry season (Yunoki et al., 2018), where harvesting techniques were inappropriate for catching swamp eels/other burrowers, and the fish were artificially concentrated. We approximate fish availability varied between 84.4 and 844 g ha-1, between 20 and 360% of terrestrial protein production. 84.4g is the average protein content of a marbled swamp eel, calculated using the length to weight ratio of Prestes-Carneiro et al. (2019, 2021), using a length estimate of 800 mm based on the size of skeletal remains identified as marbled swamp eel on the mounds. We assume 60% of the carcass is comestible, 18.7% of the remaining meat is protein (Hicks et al., 2019). During experiments, fish density is set to 4 (337g ha-1).	(Hicks et al., 2019; Prestes-Carneiro et al., 2019, 2021; Yunoki et al., 2018)

FORAGE SUPPLY	760 kg ha-1	It is not clear which economically useful species were utilised by the Casarabe culture, though many are found within the immediate vicinity of the mounds (Erickson and Balée, 2006). We focus on two of the most common: Motacu (Attalea phalerata) and Chonta (Astrocaryum murumuru). Both are abundant and regularly used local by indigenous groups (Holmberg, 1969; Ringhofer, 2010). We averaged the densities of both adult palms found by Erickson and Balee (2006;103 Motacu Palms ha-1, 63 Chonta palms ha-1). While this could be considered high, densities 3-4 times this have been recorded in other parts the Llanos de Moxos (Peacock et al., 2021). We assume only 10% of the fruits produced by these plants were extractable due to pests, competition from other animals, uneven production. This is the equivalent of extract the fruits of 17 trees per ha. Motacu palms are highly productive, offering 2 branches of 425 fruit, each of which weigh on average 74.4 g (Moraes et al., 1996). Chonta palms produce 2 branches of 243 fruit, each weighing 35.2g (Queiroz and Bezerra, 2008). Combined, this estimates a fruit supply of 760 kg ha-1.	(Erickson and Balee, 2006; Holmberg, 1969; Ringhofer, 2010)
FUELWOOD SUPPLY	1200 kg ha-1	Fuelwood production varies depending on forest type. We assume the local forests were more open than tropical high forests found further northeast. The FAO (1983a:CHVII) estimates production of 1.5 m3 fuelwood ha-1 yr-1. Assuming a density of 700-900 kg m3 (FAO, 1983b:Appendix 4), this equates to 1050-1350 kg ha-1 yr-1.	(FAO, 1983a, b)
MAIZE CROP LOSS	15%	Approximately 15% of the maize crop at Camp Bello is lost to pests (Ringhofer, 2010:99).	(Ringhofer, 2010)

MAIZE SUPPLY (CROPLAND-PRODUCTIVITY)	1500 kg ha-1	Assigning a maize yield estimate is difficult due to the variable nature of maize productivity. We select 1500 kg ha-1, sufficient to support a pre-Columbian household unit within 1 ha even after maize loss. This is both significantly lower than the 3000-4000 kg ha-1 some scholars argue was possible for pre-Columbian agricultural systems (Denevan, 2001) and significantly higher than the minimum 250 kg ha-1 known to have been produced in this region (Pérez, 1995; in: Stab and Arce, 2000).	(Denevan, 2001; Pérez, 1995; Stab and Arce, 2000)
PALM LEAF SUPPLY	206 leaves ha-1	The supply of palm leaves is estimated based on the average density of palms within the Monumental Mound Region between 2 forest plots (Erickson and Balee, 2006). We only consider Motacu, as while Chonta fronds are sometimes used in construction, it is very rare in Bolivia. Chonta fronds are also extremely difficult to extract due to their spines (Smith, 2015:64). Adult Motacu palms possess 15-20 leaves (Moraes et al., 1996). Each can produce up to 7.9 new ones annually (Lima, 2010). However, this does not mean they could fully grow during this time. Additionally, while some relatives of Motacu can tolerate losing up to 60% of their leaves at once (Pintaud et al., 2016), this may not be true. Thus, we conservatively estimate two leaves may be extracted from each Motacu palm annually (206 leaves ha-1), equivalent to 10 palms ha-1.	(Erickson and Balee, 2006; Lima, 2010; Moraes et al., 1996; Pintaud et al., 2016; Smith, 2015)

PROTEIN SUPPLY	0.23 kg ha-1	Based on the 10 mammal taxa most commonly hunted by the Siriono (Townsend, 1995, 2000). Mammals represented 77% of the animals hunted, and all but one of the top 10 were also recovered from the mounds (von den Driesch and Hutterer, 2011), indicating that the Casarabe culture targeted similar game. Few population density estimates for these mammal taxa are available for this region. Thus, we estimate based on one of the most complete datasets available (Robinson and Redford, 1986). When converting to protein, we assume that 50% of a mammal carcass is comestible and 20% of that is protein (Saadoun and Cabrera, 2008).	(Robinson and Redford, 1986; Saadoun and Cabrera, 2008; Townsend, 1995, 2000; von den Driesch and Hutterer, 2011)
TIME FOR AGROFORESTRY/FALLOW TO PRODUCE FOREST RESOURCES	7 timesteps (years)	Forest takes time to develop before forest resources can be produced. We base our minimum time upon when Motacu first fruits, at approximately 7 years (Moraes et al., 1995).	(Moraes et al., 1996)
VEGETATION			
FALLOW-AGE	3 timesteps (years)	Crop cycle length varies considerably depending on climatic conditions and soil. On open whitewater floodplains in Amazonia, it is possible to reach 20 years of continuous cropping with only a few years of fallow afterwards (see Denevan, 2001:62-8; Beckerman, 1987). These two sources provide a range of different figures under different soil types and climatic conditions. We chose 3 years (Beckerman, 1987) because (i) maize is nutrient demanding and will use up soil nutrients comparatively quickly, and (ii) a number of estimates support the idea of a three-year cropping cycle (Piland, 1991; Staver, 1989)	(Beckerman, 1987; Denevan, 2001; Piland, 1991; Staver, 1989)

FALLOW-PERIOD	6 timesteps (years)	This reflects the minimum amount of time households wait before fallowed land is considered eligible for reactivation. This value varies across the Amazon, but the Tsimane typically view 4-6 years as necessary for regrowth and weed suppression (Huanca, 1999:78), corroborating with median estimates for fallowed plot ages (8.35 years. See Piland, 1991:77).	(Huanca, 1999; Piland, 1991)
YRS-FOREST-REGEN	40 timesteps (years)	Secondary forest structure regenerates over several decades (Poorter et al., 2021). Huanca notes the Tsimane can no longer distinguish fallow from secondary forest after this time period (1999)	(Huanca, 1999; Poorter et al., 2021)
YRS-SAVANNA -REGEN	10 timesteps (years)	Herbaceous taxa rapidly become established within one decade (Finegan, 1984) and Woody Pioneers may establish in as few as 7-8 years (Peña-Claros, 2003), making it difficult to distinguish from fallowed land	(Finegan, 1984; Pena-Claros, 2003)

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