

Creolo beans production systems in Juruá valley, Acre, Brazilian Amazon

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The Juruá valley Mesoregion is recognized for its diversity of cultivars of common beans and cowpea and is an important center for *on farm* bean conservation in Brazil. However, there is little information about production systems of *Creoles* cultivars and, in this approach, the study aimed to identify the production centers and to gather information about beans production systems. Thirty eight farmers and five merchants were interviewed using semi-structured questionnaires. Juruá valley farmers use three beans production systems: "beach farming", "slash burn system" and "stuffy farming". The systems use family labor with low dependence on external inputs, two classified as itinerant. The study identified two beans production centers: *Alto Juruá* extractive reserve and *Santa Luzia* directed settlement project.

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Mattar *et al.* (2011) reported the existence of 25 bean cultivars between common and cowpea beans that are grown in the Juruá valley mesoregion¹, characterized by geographic isolation and high number of family farmers. Oliveira *et al.* (2015) described 9 cowpea cultivars produced on Juruá river banks². Although there is not much information about the region, it contains one of the biggest diverse sets of beans preserved *on farm* in Brazil, in which reality serves as a very important protein source to the local population^{3,4}. Acre's Juruá valley holds this feature for been located close to the *Phaseolus vulgaris* L. genetic diversity center, and also from receiving rich cowpea genetic material brought from Brazilian North east migrants and common beans genetic material brought from colonizers. These cultivars have a great social, economic and cultural importance, been planted on floodplain and firm land by smallholders agriculture based families. On the other hand, of its huge importance, there are not many research studies about the subject. Furthermore, there is no information on the traditional cultivars productive chain that finds itself on genetic erosion influenced by

a new local dynamic, being the main cause the asphalt road (BR 364) between the cities Rio Branco and Cruzeiro do Sul, in Acre, Brazil. The knowledge about the traditional production systems will encourage actions centered on aggregating value to the smallholder production. The smallholder production in Amazonia possesses global importance considering the role it plays on genetic resources conservation and primary forest preservation. Jasmine *et al.* (2016) highlighted the importance of the traditional knowledge to conservation and sustainable use of the biodiversity⁵ and Khumalo *et al.* (2012) reported that the genetic erosion main cause is the substitution of the local varieties for commercial ones, and that the adoption of sustainable practices that use and preserve the biodiversity can limit the agriculture expansion in natural forests⁶. Fujisaka *et al.* (2011) draws attention to the fact that access to agro-biodiversity will be crucial to adapt the food production to the climate changes⁷. Guerra *et al.* (1998) presents concerns about establishing strategies to characterize and preserve the plants genetic diversity⁸. Jackson *et al.* (2007) pointed out the demand of partnerships between researches and farmers to integrate ecologic or socioeconomic

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studies to know how the agro-systems can help preserve the genetic resources⁹.

In regards of the actions planning in order to encourage the diversity conservation, the basic information about production and commerce must be used for an adequate decision-making. In this purpose, this study has as objective to identify the production centers and diversity and to characterize the cowpea and common bean production systems developed by the small farm families in the Vale do Juruá mesoregion.

Methodology

The study was conducted from November 2009 to December 2012 and integrates the agronomic classification of creole beans Juruá valley. The activities consisted on: obtaining official authorization to conduct field research and technical visits and interviews on family production unities and commerce centers. In Cruzeiro do Sul (Acre, Brazil) the research execution was officially communicated to the *Instituto Chico Mendes de Conservação da Biodiversidade* (ICMBio) and to the *Instituto Nacional de Colonização e Reforma Agrária* (INCRA), federal branches that administrate the conservation unities and agrarian reform, respectively. At every visit to farmers and commerce owners the project objectives and work activities were presented. Only after individual authorization, the semi-structured interviews were conducted using a previous elaborated script.

Regarding the interviews with the intermediaries, the script contained the following topics: a) what are the commercialized regional cultivars?, b) Where the regional cultivars are produced?, c) Who are the farmers with bean production experience?, d) When witch one of the regional cultivars are sold?. To the farmers, the script contained the following questions: a) What is the seed origin?, b) When do you seed ?, c) When do you harvest?, d) What cultivar do you seed?, e) What are the steps on the bean production?, f) What are the inputs and tools used on the production?, In this field research, 38 farmers and 5 intermediaries were interviewed. The interviewers team held visits to the regional commercialization centers “*Minhocão*” and “*Samambaia*”, popular names are “*Beira Rio*” and “*Mercado do Agricultor*”, respectively. Both are situated at Cruzeiro do Sul (Acre, Brazil) central part adjacent to the Juruá river, where the agriculture products are usually sold. In Marechal Thaumaturgo,

located in the South west area of Acre state, visits were held to the town market and weekly fair. To verify the *on farm* bean production, 5 scientific expeditions were conducted through Juruá river and tributaries, especially on the domains of the Alto Juruá Extractive Reserve (RESEX Alto Juruá), adopting as a start point Marechal Thaumaturgo city. The river path covered had as limit points the border between Federative Republic of Brazil and Republic of Peru to the Cunha Gomes line, that divides Acre and Amazonas state, in Brazil. On Alto Juruá Extractive Reserve, the rivers Juruá, São João, Amônia and Tejo were covered. The rivers were covered on two periods: In 2010 from May and August, and, in 2011, February and August. The covered sections were 1) Upwards Juruá river from Marechal Thaumaturgo to the Republic of Peru above the “*Breu* community”; 2) Upwards Amonia river from Marechal Thaumaturgo to “*Pifaião*” community; 3) Upwards Juruá river from Marechal Thaumaturgo to the “*Belfor*” community; 4) Upwards Juruá river from Marechal Thaumaturgo to the river mouth between Tejo and Juruá rivers and going upwards Tejo river to “*Boa Vista*” community; 5) Upwards Juruá river from Marechal Thaumaturgo to the river mouth between Juruá and São João rivers to the “*Morro da Glória*” community upwards São João river; 6) Downwards Juruá river from Marechal Thaumaturgo to the “*Triunfo*” community. Additionally, two land expeditions were conducted jointly with the “*Santa Luzia*” Directed Settlement Project (PAD Santa Luzia), going on the BR-364 road that connects Cruzeiro do Sul to Rio Branco, more specifically on the settlement adjacent road referred as “*Ramal III*”, adopting as start point Cruzeiro do Sul city.

Results and discussion

The Alto Juruá Extractive Reserve (RESEX Alto Juruá) and the Santa Luzia Directed Settlement Project (PAD Santa Luzia) stood out as bean production centers in the Vale do Juruá mesoregion, Acre state, Brazil. The Alto Juruá RESEX, the first extractive reservation in Brazil, acknowledge in 1990, posses 506.186,00 ha and 1490 resident families; the PAD Santa Luzia, acknowledge in 1980, posses 62.267,87 ha and 880 resident families¹⁰. In this research, three production systems, developed to common and cowpea beans, were characterized. On proprieties located on Juruá river and tributaries

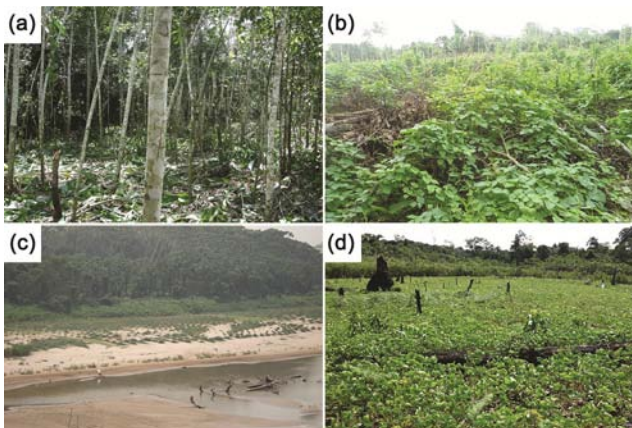


Fig. 1—Bean production systems in Juruá Valley: (A) Stuffy system implantation, selective deforestation step (B) Bean climbing on the branches, stuffy farming system in the RESEX Alto Juruá (Pictures by Antônio Silva de Jesus, donated for research) (C) Beans being cultivated on the Juruá river beach (D) Beans cultivated under the slash and burn system on the PAD Santa Luzia.

banks, especially on production unities located on the RESEX Alto Juruá, the farmers practice two production systems, named “stuffy farming” (Figs. 1A&B) and “beach farming” (Fig. 1C). On the PAD Santa Luzia the farmers use the “slash burn system (Fig. 1D). All the systems are characterized by the use of family labor. The seeds are stored from one harvest to another, by the farmers themselves, in PET bottles and sealed plastic or metal barrels. The genetic material interchange between farmers is a common event. The “stuffy farming” and “beach farming” systems do not use chemical fertilizers or correctives, being the low usage off external inputs prevailing on the three systems. The “slash burn system” and “stuffy farming” are classified as intermittent for adopting fallow areas.

The beach farming system is associated with the Juruá river and tributaries hydrologic cycle. The seeding can only be done on the Amazonia summer, when floodplains are dry and the pluvial beaches are formed, between April and August. May is characterized by the start of the dry season and September by the start of the rain season on the region. The seeding on the last two systems (stuffy farming and slash burn system) occurs on Amazonia winter, that being, the rain season between January and March, in some cases April, depending on the year. The systems planted on firm lands resort to common bean varieties with productive cycle of approximately 4 months. The harvest is accomplished predominantly between June and August; in some

cases starting on May, when the seeding is done in January; or September when seeding is done by March/April. Regarding the systems conducted on the Juruá valley region, the main differences are on the season, area preparation, varieties planted on each system (specially the species and cycle duration), seeding spacing or the lack of it. The three systems provided farming conditions for a long period without significant environment degradation or production reduction, following the bases of indigenous tribal agricultural practices as proposed by Venkatesan *et al.* (2016)¹¹.

Stuffy plantation

The system is developed by the Alto Juruá RESEX and surrounding areas farmers, on areas close to the rivers: Juruá, São João, Breu, Tejo, Arara e Caipora. The stuffy farming system implantation is done in firm lands, with natural vegetal cover on advanced stages and soils classified as *Luvi soil*¹² and *Cambi soil*¹³. The planting is usually done in 1-2 ha areas. The system installation is divided in 4 steps: selective deforestation; broadcast sowing; slash the larger trees and manual harvest. In the selective deforestation the farmer cut, using a machete, the small and medium trees ranging from 1.5 - 2 m (Fig. 1A). In sequence, the seeding happen, the seeds are spread by random toss, not following a standard spacing. The lack of a standard spacing at this case contribute to the plant development, considering that the area doesn't stays clean and the seedlings, in the early development stages, in order to not etiolate, need to seek spaces with more luminosity. After germination, when the seedlings reach 3 - 5 cm height, the larger trees are slashed and the vegetal residues are maintained on the area. On this system, the tree shadow is maintained until the seedlings development, providing special microclimate in comparison to the full sun system. There are no conventional soil preparation practices, soil correction or fertilization. On the larger trees slash operation, the cut is done on the plant base using: axe, machete or chainsaw. After the knock down the vegetal residues are kept spread all over the area, the bean plants are going to develop using the residues and branches as tutor (Fig. 1B). During the crop conduction there are no agricultural practices such as weeding. The farmer only returns to the area on the harvest occasion. After the bean pod maturation, begins the manual harvest. The bean production is done only one time on the area, in other words, only in the first year. In the second year, the

farmer introduces the “*coivara*” system, or slash and burn system; to produce, in sequence, maize (*Zea mays* L.), cassava (*Manihot esculenta* Crantz) and dryland rice (*Oryza sativa* L.), in consortium or single crop. After the 2 yrs period the area is abandoned to natural recover and bush growing. Cravo *et al.* (2009) describe the use of similar systems, denominated as well as stuffy farming, in Maranhão and Pará states, differing by the use of cowpea beans, less dense bush vegetation in the production area and by presenting only the slash step, not being necessary a selective deforestation¹⁴.

The stuffy farming system showed average yield of 520 kg/ha, considered small when compared to the single crop system, however reduces the risk of production loss due bean web blight, common and serious disease in Amazon, caused by *Thanatephorus cucumeris* (Frank) Donk. The cultivars planted under this production system are: *Peruano amarelo* (Yellow Peruvian), *Peruano branco* (White Peruvian), *Gorgutuba vermelho* (Red Gorgutuba), *Gorgutuba branco* (White Gorgutuba), *Roxo de thaumaturgo* (Purple of Thaumaturgo), *Gorgutuba Rajado Amarelo* (Brindle yellow Gorgutuba), *Preto do Alto Juruá* (Alto Juruá Black), *Gorgutuba Bege* (Beige Gorgutuba), *Gorgutuba Rajado* (Brindle Gorgutuba), *Gorgutuba Amarelo* (Yellow Gorgutuba), *Mudubim de Vara* (Stick Mudubim) e *Preto de Rama* (Foliage Black), (Fig. 2), all belonging to the *Phaseolus vulgaris* L. species and owing a climbing habit.

Beach farming

Beach farming is developed by farmers localized on river side areas by the muddy rivers such as *Juruá*, *Tejo*, *Amônia*, *São João* and *Breu*. The muddy water possesses high levels of suspension material, being common to the rivers originated in the Andes. The planting, in this system, is done on the beaches and river banks, denominated as low floodplains as well, that arises during the rivers ebb, condition that favors an annually fertility renovation by the nutrient deposition during the flood. The low floodplains present soils locally called as “*white mud*” and “*floodplain sand*” being classified, respectively, as: *Gleisoils* and *Fluvic Neosoils*¹⁵. The *glei soils*, predominantly present high activity clay, however it can show high exchangeable aluminum levels; they don't have big fertility problems¹⁵. The beach sediments of Juruá river showed more silt on its composition, composed of: quartz, smectite, illite, kaolinite and feldspars¹⁷. These sediments are

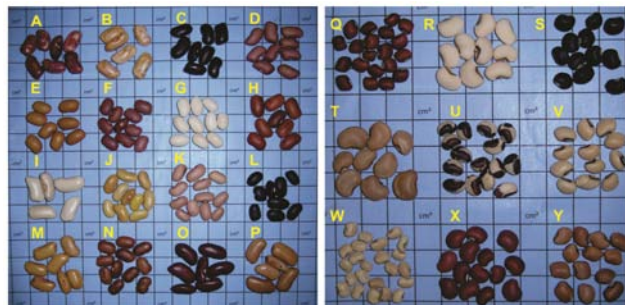


Fig. 2—Common bean: A. Red Brindle Gorgutuba, B. Yellow Brindle Gorgutuba, C. Alto Juruá Black, D. Purple Thaumaturgo, E. Yellow Peruvian, F. *Mineirinho*, G. White Peruvian, H. Stick Mudubim, I. White Gorgutuba, J. Sulfur, K. *Rosinha Pitoco*, L. Foliage Black, M. Yellow Gorgutuba, N. *Carioca*, O. Red Gorgutuba, P. Beige Gorgutuba, Cowpea: Q. Buttery Purple, R. *Quarentão*, S. Foliage Black, T. Foliage Mudubim, U. Little Owl, V. White Beach, W. Buttery, X. *Arigozinho* e Y. Beach Purple. The cowpea image was previously used by Oliveira *et al.* (2015).

composed mostly by SiO₂, followed by Al₂O₃, Fe₂O₃, K₂O, CaO, MgO; P₂O₅ being found as apatite and adsorbed on smectite¹⁸. The chemical and mineralogical characteristics cause these sediments to be similar to eutrophic cambisol, therefore, considered fertile soils¹⁸. According to Costa *et al.* (2006) the beach sediments of Juruá river basin as well as the beans produced on it are low on Hg, not presenting any risks to human consumption¹⁹. The cowpea cultivars used on this system are: *Manteiguinha* (Buttery), *Manteiguinha Roxo* (Purple Buttery), *Corujinha* (Little Owl), *Quarentão*, *Mudubim de Rama* (Foliage Mudubim), *Branco de Praia* (Beach White), *Preto de Rama* (Foliage Black), *Roxinho de Praia* (Beach Purple) e *Arigozinho* (Fig. 2). The productive cycle takes approximately 2 months (60 days) and farmers reported that each crop can be harvested 2 or 3 times. Seeding is done by using hoe when ebb starts; first on the bank areas situated adjacent to the beach. The standard spacing adopted between pits is 1 x 1 m. As the water level goes down, usually on the month of May, some farmers seed directly, by toss, on the beach. In this system, it is not observed the practice of fertilizing or soil pH correction. In years with high rainfall, flood may occur affecting the crop and its yield. In areas with high numbers of spontaneous plants, as “*Canarana*” (*Hymenachne donacifolia* (Raddi) Chase), common on river banks, farmers perform weeding, 2 or 3 times, called as “*clearing*” on the region, using machetes or hoes. After full maturation of the pod, harvest is done manually, that occurs raging from august to September. On August the

rainfall is low and the end of the dry season and start of the rain season characterize September. The cowpea bean crop on floodplain, on the same system, is reported to be done on the central part of Amazonas state by Pereira *et al.* (2006)²⁰, on the Madeira river basin²¹ and beaches on rivers on Juruá valley and Purus, Acre state²².

Slash burn system

The beans are cultivated on firm land on the traditional “*coivara*” system, common on agriculture on Amazonia. On “slash and burn”, the vegetal cover, composed by dense bush or primary forest is knock down on areas ranging from 1-2 ha. After the cut, the vegetal residues are burn and the crop seeding starts: cassava, maize, rice, and cowpea beans. After 2 yrs, occurs the soils fertility decrease, in which occasion the areas are abandoned and left to natural recovery.

Proprieties on the PAD Santa Luzia, Cruzeiro do Sul city, Acre state, are featured by the common bean production using this production system, and farmers brought some of the cultivars during the colonization process. These proprieties possess soils classified as Clay soils¹²; that, according to ARAUJO *et al.* (2005)²³ have low to average natural fertility, due to the low activity clay minerals predominance, and present susceptibility to erosion for being associated usually to irregular terrain.

The seeding usually take place on May to June, beans are usually planted on pits using manual seeders or hoes. Harvest is manual and happens on August to September, a period with low rainfall, as related in other systems.

The spacing between plants and lines diverge among farmers. The spacing more commonly used on the region is: 0,5 or 0,4 m between lines and 0,2 m between plants. On some productive unities its common the chemical fertilizing practice, soil correction and pulverizing as well to control insects and diseases.

The common bean cultivars used are: *Carioca*, *Rosinha Pitoco*, *Enxofre*, *Mineirinho Roxo* and *Feijão Preto* (Black Bean). These cultivars possess erect or bush habit plants; not being necessary staking. The most common cowpea bean cultivars are *Quarentão*, *Barrigudinho* e *Manteiguinha* (Buttery) (Fig. 2).

The data generated by this research is relevant to support actions that aim to certificate and add value to the regional bean production. Those actions would

encourage *on farm* conservation and improve the life of the traditional populations.

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