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Domestication past and future of tribal agriculture in Bastar

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Abstract
Wild edible fruits play an important role in the nutrition, medicinal and traditional lifestyles of the local people. Bastar region is rich in its biodiversity and tribal communities who are dependent on wild resources for the sustenance. The main forest is sal, Harra, Bahera, Char, Tendu, Palash. Most of the people are either engaged in livelihood through agriculture or forestry-related options. The economic condition of the people is also below the national level as reflected in per capita income. Wild edible fruits of this region are not only consumed but are also sold in local markets. There is a need to domesticate the fruits at the same time there is a need to develop cultivable improved varieties and the study nutritional aspect to design better foods for the future. Although these wild edible plants play an important role in food security, they are ignored. The primitive man through trial and error has selected many wild edible plants, which are edible and subsequently domesticated them. Allopatric speciation, also referred to as geographic speciation, vicariant speciation, or its earlier name, the dumbbell model, is a mode of speciation that occurs when biological populations of the same species become isolated from each other to an extent that prevents or interferes with gene flow. Wild edible is less susceptible to diseases, can be grown easily without the application of pesticides. Ironically these plants are still unknown or less known to other parts of the world. The wild edible plant species will be popularized after phytochemical analysis and nutritional studies. The present study on the review of "Domesticable Hidden Wild Botanical Gems of Forest" will be helpful in pooling different types of edible plant species utilized by various tribes in different parts of the forest.

Keywords: Wild edibles, bastar botanical gems, plant utilization, domestication, mutation breeding

Introduction
To bring a plant from wild to home or farm to be cultivated by and beneficial to human beings it's the domestication of plants. The adaptation of plants was one of the greatest substantial artistic and developmental metamorphoses in the past of our agricultural history for humans. Studying where, how, and when domestication took place is therefore fundamental for understanding the roots of convoluted societies. Domestication research is so significant to scholars from a wide range of disciplines, from developmental biology to sustainability science. Plant domestication can be thought of as a two-step process. In the first step, plants acquire traits in what is called the "domestication syndrome" that makes the plant worth the labor of cultivation. These include traits that allow a crop to be reliably sown, cultivated and harvested, such as uniform seed germination and fruit ripening. In the second step, the now domesticated plant is selected for improved qualities. It is in this stage, for example, that farmers might breed many different varieties of a crop that differ in grain taste, fruit color or fruit shape. Although often characterized as rapid and the result of explicit human intention [1, 2], domestication is a complex process along a continuum of human, plant, and animal relationships that often took place over a long-time period and was driven by a mix of ecological, biological, and human cultural factors [3, 4]. Darwin believed that breeds were formed by both natural and artificial selections, "The key (to domestic breeding) is man's power to accumulative selection: nature gives successive variations; man adds them up in certain directions useful to him" [5]. When selective pressure acts on individuals, it leads to the changes in genetic content in the population [6]. The wild food also called emergency food, as apparently, it implies the absence of human interference and management, but, such food plants, result from the co-evolutionary relationship between humans and the environment. Most crop plants differ from their wild progenitors in a simple quantitative way. For example, wild tomato is merely a small-fruited version of the large-fruited domesticated tomato. Unlike most crops, maize has no morphologically equivalent wild form, and so the identity of the wild

progenitor of maize was a topic of considerable interest in the early 1900s. The stunning morphological differences between the ears of maize and teosinte seemed to exclude the possibility that teosinte could be the progenitor of maize. However, it was also known that maize and teosinte could be readily crossed and that maize and some types of teosinte formed fully fertile hybrids [7]. Increasing demands for high-quality food from a growing, increasingly affluent global population coupled with climate change and a shrinking resource base (arable land, N, P, etc.) create the perfect storm for society, where agriculture is being asked to produce more from less. To meet this challenge, agriculture must deploy all the tools at its disposal. In the context of crop improvement, this means identifying and exploiting all the useful genetic diversity available in our crop gene pools (e.g., introgression/domestication from CWR), as well as widening our vision to domesticate new crops [8]. Domesticated cultivated plants are resulting from a phylogenetically dissimilar group of uninhabited, progenitor through artificial selection for diverse characters.

Domestication syndrome

Domestication syndrome was describing the suite of phenotypic behaviors arising during domestication that discriminate crops from their wild ancestors. In other words, it is the subset of qualities that collectively form the visual and agronomical differences among crops and their wild ancestors. The suite of traits that marks a crop's divergence from its wild Ancestor (s) is defined as the 'domestication syndrome' [9, 11]. A domestication syndrome may include combinations of several different traits, including seed retention (non-shattering), increased fruit or seed size, changes in branching and stature, change in reproductive strategy, and changes in secondary metabolites. The domestication syndrome may evolve over thousands of generations, as desirable traits are selected for in the agricultural environment and become fixed within the crop genome [12]. The domestication syndrome may also evolve within a short time frame, as in the cases of crops domesticated within the last 100 years or so (e.g. kiwi, cranberry).

Most of the Cultivated Plants (Botanical Gems) are Human Choice from Whole Wild Plant Diversity (Gems Mines)

It is estimated that on the earth, there are between 370,000 and 500,000 species of higher plants, of which approximately 369,000 have been described [13]. Many species are still unknown to science, while perhaps a third is at risk of extinction [14]. At present, the Angiosperm Phylogeny Group [15] recognizes 462 families of flowering plants (angiosperms). Given that most plant species living today are likely to have existed for millions of years; our human ancestors would have known and used many of them for tens to hundreds of thousands of years. However, our present knowledge of domesticated plants largely reflects our experience of a relatively small number of living domesticates adapted to recent, Holocene environments. The number of plant species used for food by pre-agricultural human societies is estimated to be around 7000, of which only a tiny fraction was domesticated [16]. Although archaeological evidence indicates the beginning of agriculture from the late Pleistocene and early Holocene onward, human interactions with plants that are now domesticated are likely to have started much earlier [17], establishing traditions and archetype views of plants that remain today. Although human dietary habits are rather plastic [18], most people in each society follow established food traditions, making adjustments only when necessary. Many cultivated plants have only minor use in particular regions or on specific occasions. Instead, humanity relies on a small collection of crop plants for the majority of our dietary intake. Indeed, <20 plant species together provide about 95% of the world's calorie intake. These include bananas/plantains, beans, cassava, maize, millet, potatoes, rice, sorghum, soybean, sugar cane, sweet potatoes, wheat, and legumes such as lentil, pea, and chickpea [19]. This application on a few cultivated crops is an important component of the exposure of the world diet supply to the effect of climate change and the epidemic of major new plant diseases and pests. With so selected species grown as main crops, there is a big risk for epidemic outbreaks of disease and pests.

What are the methods for the domestication of wild plant species as an imaginable crop?

In bastar edible wild plants available which have interesting features that having commercial validity. To acquire benefits from such a plant commercial cultivation is needed. So that developing the wild plant as a crop plant is required. But the question is what are the methods for the domestication of wild plant species as a potential crop available for this. Developing a potential crop from wild plant species has some general ideas are: 1) Enlarged part of the interest in the plant (root, leaves, fruit, seeds) as result of prolonged growth stage or faster growth rate for this particular part (delayed transfer to next stage of plant development). 2) Reduced unwanted traits (toxic/bitter compounds), hardness due to lignin or cellulose accumulation in the used parts of plant 3) Increased uniformity of plants in population/cultivar and stability of their traits under different environmental conditions (for instance some double-zero canola cultivars accumulate erucic acid and glucosinolatesat colder climate). 4) Better technological properties for seeds production/vegetative propagation and in some cases there is an indication that domestic plants have originated from a single wild plant genotype with desirable traits. For developing a potential crop from wild plant species, domestication is the process in which selection method should be adopted for desired quality, economic yield and also market preference should be studied before introducing it as a newly domesticated species and before it's done in first out of the wild genetic material, select for higher yields, and if it a grain, select for the plants where the seeds that do not shatter easily, and for fruit, the larger fruit and the more productive plants. Also, plant structure might be important, like shorter or taller plants, or more uniform heights, so they are easier to machine-harvest. Also, uniform ripening dates, for machine harvesting is good to cut. Methods vary between one species to other species of interest, it is difficult to give a straight answer, but the following techniques/tools are also will be required: Molecular methods like Induced mutagenesis at gene (point mutations e.g. EMS), chromosome (e.g. translocations - gamma rays), genome (polyploidy - colchicine, oryzalin) levels. Convention breeding methods like Interspecific hybridization (especially important if you have any domesticated species related to the species of interest) involving overcoming of pre- and post-zygotic barriers (e.g. embryo rescue). Selection methods like Selection are depended on characters you wish to improve (e.g. colour or size of organs, plant architecture) or remove (e.g. thorns, alkaloids for food use). So, selection can use field observations, biochemical, genetic (pleiotropic genes are very helpful to cull at early stages e.g. soybean seedling colour corresponds to the seed coat colour, so you can select without waiting for the maturity of plants) or molecular markers. We have examples of domestication of wild species within 4- 5 generations using these methods in the 'modern era' compared to thousands of years when it occurred before Mendel, Vavilov, Watson and Crick *et al.* For instance, social cultures have progressed so have the plants in the hominoid atmosphere. The conversion from collecting wild plants to agriculture elaborate increasing collaboration between humans and the plants they used. The subsequent genetic fluctuations in these plants consequential in the domestication of some of these cultured species reflect the genius of early agriculturalists, who were the first plant breeders. The present group of plant breeders has implements available that allow them to be plant engineers. Breeding and conversion have both been elaborate at the beginning of crops and the practice of domestication from the time when primary times. Bread wheat, which is a hexaploid (2n = 6x = 42 chromosomes), arose through fortuitous hybridization between tetraploid wheat (*Triticum turgidum* ssp. *dicoccum*, 2n = 4x = 28) and diploid goatgrass (*Aegilops tauschii*, 2n = 2x = 14), a weed of early wheat fields. New groups of bananas and plantains developed when diploid domesticated bananas (genome AA) spread into the range of wild *Musa balbisiana* (genome BB), producing the AAB and ABB triploids [20].

Environmental serious hazards Impacts due to domestication?

Genetic bottleneck: It is a reduction in the genetic assortment while choosing only for the favorite alleles, but this is not the case in weeds because weeds are the major threat to crops from the beginning of domestication till today. There is a strong natural selection pressure which makes the sustaining genes over a long period through which weeds can compete equally with the newly introduced variety or quickly/simultaneously with the existing crop.

Crop mimicry: Some wild plants have developed crop genes that make them more operative agronomic weeds. Those genes mimic the pattern of domesticated ones and thus escape removal in agronomic sites by farmers. The weed may look identical to the crop until seed dispersal, or the weed seeds may be impossible to separate from the agronomic source. Eg. Sugar- beet bolts in Europe.

Genetic assimilation: examples of genetic assimilation and demographic swamping have been observed in interactions between crops and wild relative's viz., Hybridization with cultivated rice led to the near extinction of the endemic Taiwanese taxon, *Oryza rufipogon spp*. *formosana* through genetic assimilation. Most populations of native Asian subspecies of *O. rufipogon* may be endangered through hybridization with the crop.

Genetic evolution/ changes: The degree of genetic change is associated with speciation. Molecular markers are increasingly being used to construct genetic maps of species, and these maps have expanded our knowledge of genome structure and evolution. By comparing maps of related species, it is possible to evaluate the kinds of genomic changes that accompany speciation [21]. Domestic races of animals and cultivated races of plants often exhibit an abnormal character as compared with natural species; for they have been modified not for their benefit, but for that of man [22].

Adaptations to host-shifting of domesticated species: In response to pest damage, agricultural producers have bred domesticated varieties for higher resistance, or tolerance, to numerous antagonists. This approach is common in crops [23] and is gaining interest in livestock [24]. Yet, wild antagonistic species have repeatedly, and often very quickly, evolved counter adaptations to these new resistant varieties [25]. The best-known example of this is the repeated development of cereal cultivars resistant to fungal pathogens in the mid-twentieth century. Pathogens very quickly, and repeatedly evolved mechanisms to overcome these new resistant varieties within only a few years. For example, Colias butterflies have shifted hosts from wild legumes to domesticated alfalfa, leading to genetically distinct 'pest' and 'non-pest' populations, each of which performs better on its host [26]. In this assessment, we can categorize existing evidence that farming drives evolution in wild species through three developmental components. First, because domesticated species differ greatly in their phenotypes compared with wild ancestors, selection can favor wild species to specialize in traits of these over-abundant organisms. Second, at least three types of agricultural practices create strong selective pressures that drive the evolution of wild species. These practices include agricultural intensification and the control of antagonistic species either through cultural practices, such as crop rotation or through the use of pesticides and genetically engineered (GE) species. Third, agriculture also causes evolutionary changes in wild species through non-selective mechanisms such as gene flow. This can occur either directly, i.e. genetic exchange can occur between domesticated species and wild relatives, or indirectly, i.e. agricultural practices, such as the transportation of livestock, can alter the genetic structure of non-related species [27].

At the present need of Crop Domestication

Increasing demands for high-quality food from a growing, increasingly affluent global population coupled with climate change and a shrinking resource base (arable land, N, P, etc.) create the perfect storm for society, where agriculture is being asked to produce more from less. To meet this challenge, agriculture must deploy all the tools at its disposal. In the context of crop improvement, this means identifying and exploiting all the useful genetic diversity available in our crop gene pools (e.g., introgression/redomestication from Crop Wild Relatives), as well as widening our vision to domesticate new crops [28]. It can be constructed with knowledge-led approaches based on current needs using the range of new technologies now available. Plants exploited for continuous selection introduction hybridization etc. which boosted the process of domestication but now the plant genetic engineering approach is exploiting plants towards synthetic biology is nothing but we can call it as super domestication. The major tools to support super-domestication are:

1. Efficient utilization of the existing diversity; by crossing two varieties/species/genera, Genome manipulations, producing Cell fusion hybrids, etc.
2. Chromosome manipulation: Alean line development (Alien addition and substitution), ploidy manipulation.
3. Generate recombinants: Chromosome recombination.
4. Utilizing the technique like genomics, proteomics, metabolomics, transcriptomics, and other omic techniques.

5. Other major tools: Transgenic approach, Modern mutagenesis (TILLING), synthetic gene construction by utilizing green florescent protein, genome editing, NGS, GWAS, sequencing, other synthetic biology [21].

Human interventions in plants of economic, cultural, or nutritional importance via traditional practices (domestication) and, more recently, via GE have a long history in crop management. Despite the major importance of the consequences of these human-driven interventions in crops, no systematic investigation of the actual consequences in plant populations exists [29].

Wild Plants Birthplace of Required Characters

The crop plants and their wild progenitors may spontaneously hybridize with each other when grown side by side [30]. This may result in the infiltration of wild genes to the cultivated germplasm and *vice-versa.* This process is called introgression or introgressive hybridization [31]. It is frequently observed in cross-pollinated crops than in the self-pollinated ones. Accomplishments of interspecific crosses between crops and their related types have opened new dimensions in the utilization of wild relatives in various crop improvement programs. The value of wild relatives was better recognized with findings of *Zea diploperennis*, a new teosinte from Mexico [32] and *Oryza nivara* from India [30]. Crossability of *Allium cepa* and *A. sativum* with *A. roylei* (a species of Indian origin) has opened a new avenue for the utilization of Indian wild species. This species has been used for transferring resistance for powdery mildew and leaf blight in the cultivated taxa [33]. The germplasms collections of major crop plants have been built-up and cataloged. The wild relatives have been identified as a source of the following desirable traits in the improvement of crop plants. Resistance to diseases and pests: paddy, chickpea, pigeon pea, sesame, brinjal, lady's finger and potato. Tolerance to adverse environmental stress (salt tolerance, heat/ frost, desiccation sensitivity, water flooding): chickpea, pigeon pea and soybean. High vegetative vigour: sugarcane and potato. Higher yield: chickpea, mung, urd and lady's finger. Morphological traits: wheat, pigeon pea and lady's finger. Higher protein value: oat, pigeon pea and cassava. Higher oil content: coconut and oil palm. A total of 22 wild edible tubers were identified and recorded as food sources in bastar region were *Amorphophallus paeoniifolius, Asparagus racemosus, Chlorophytum borivilianum, Colocasia esculenta,Costus speciosus, Curculigo orchioides, Curcuma amada, Curcuma angustifolia, Curcuma caesia, Dendrocalamus strictus, Dioscorea alata, Dioscorea bulbifera, Dioscorea hispida, Dioscorea oppositifolia, Dioscorea pentaphylla, Dioscorea bulbifera* var. *pulchella, Hibiscus rugosus, Ipomoea batatas, Leea macrophylla, Pueraria tuberosa, Scirpus grossus, Urginea indica* [34].

We humans today depend for our survival on that tiny fraction of wild species that has been domesticated. Might the rise of molecular biology, genetics and understanding of animal behaviour help feed our growing numbers by increasing that tiny fraction? Modern science has indeed made it technically possible to 'domesticate' species un-domesticable in the past, in the sense that we achieve far more draconian control over the captive breeding of endangered computer-matched for mating to maximize genetic diversity than the low-tech control that ancient plant breeders exerted over their crops. But although this 'domestication' is of great interest to conservation biologists, it holds no promise of a condor industry to displace plants from the supermarkets. What wild species might now be domesticated with profit? Our best hopes for valuable new domesticates lie in recognizing the specific difficulties that previously derailed domestication of particular valuable wild species, and using modern science to overcome those difficulties. For instance, now that we understand the polygenic control of non-bitterness in acorns, perhaps we could use that knowledge to select for oaks with non-bitter acorns, just as ancient farmers selected for non-bitterness controlled by a single gene in almonds. Providing undernourished people with more food would be a laudable goal if it were inexorably linked to reducing our numbers, but in the past, more food has always resulted in more people. Only when crop breeders take the lead in reducing our numbers and our impacts will they end up by doing us net good.

Wild edible plants of Bastar District used by tribes that can be domesticable and cultivated after genetically improved.

S. No.	Botanical Name	Familly	Local Name	Use	Breeding goals
1	*Aegle marmelos,* Linn.	(Rutaceae)	"Bel"	The ripe fruit is eaten by the tribal.	Increase the sugar content, reduce the seeds or seedless variety can be developed, eliminate Vivipary, increase fiber content.
2	*Bauhinia racemosa*, Lamk.	(Fabaceae)	"Kathmohila/ Koliyari"	Its ripe fruit is eaten by tribal	High green pod yield, long attractive green pods with more seeds, sweetness, high shelling percentages, Bush/pole plant type.
3	*Bombax malabaricum*, D.C.	(Bombacaceae)	"Semar/Semal"	The young flower buds mixed with Mahua flowers are eaten during food scarcity	Increase essential oil and colour in flower, increase sugar content in flower
4	*Buchanania lanzan*, Spreng.	(Anacardiaceae)	"Char/Chiraunji"	The ripe fruits and its seeds are eaten	Increase seed size and thickness of pericarp, Earliness, uniform fruit ripeness, Bush/pole plant type, per cluster fruit number increase.
5	*Dendrocalamus strictus*, Nees.	(Poaceae)	"Bans"	The sprouts are cooked as a vegetable	Reduce bitterness f sprouts, increase the snootiness and tenderness, and eliminate the dormancy.
6	*Dioscorea*	(Dioscoreaceae)	"Gethikanda/Girhorakanda"	The tubers are used as a	High Tuber yield, earliness, High

	sativa, Thunb.			vegetable along with salt after boiling	starch, increase tuber size, reduces the bitterness of tuber.
7	*Dioscorea pentaphylla*, Linn.	(Dioscorecaceae)	"Khanima kanda Chheira Kanda" The tubers are used as a vegetable along with salt after boiling	The tubers are used as vegetables along with salt after boiling. Some lemon or tamarind is also added to the tuber to remove its bitterness, The tubers are collected in bulk and kept in shade during summer and in times of food scarcity.	High Tuber yield, earliness, High starch, increase tuber size, reduces the bitterness of tuber.
8	*Diospyros melanoxylon*, Roxb.	(Ebenaceae)	"Tendu"	The ripe fruit is eaten	Increase the sugar content, reduce the seeds or seedless variety can be developed, increase fiber content.
9	*Ficus benghalensis*, Linn.	(Moraceae)	"Bargad/Bar"	The ripe fruits are eaten	Increase the sugar content, reduce the seeds or seedless variety can be developed, increase fiber content.
10	*Ficus racemosa*, Linn.	(Moarceae)	"Gular/Dumar"	The ripe fruit is eaten and unripe fruit is cooked as a vegetable	Increase the sugar content, reduce the seeds or seedless variety can be developed, increase fiber content.
11	*Ficus religiosa*, Linn.	(Moraceae)	"pipar/Pipal"	The ripe fruit is eaten	Increase the sugar content, reduce the seeds or seed less variety can be developed, increase fiber content.
12	*Grewia hirsuta*, Vahl.	(Tiliaceae)	"Gursakri"	Its young fruits are edible	Increase the sugar content, reduce the seeds or seedless variety can be developed, and increase fiber content.
13	*Indigofera casioides,* Rottl.	(Fabaceae)	"Girhul/Birhul"	Fruit-Pod the flower bud is cooked as vegetable & curry	Increase the sugar content, reduce the seeds or seedless variety can be developed, increase fiber content.
14	*Ipomoea pestigridis*, Linn.	(Convolvulaceae)	"Bilariputa/Hirankhuri"	The seed is eaten by the tribal children after slight roasting	Increase the sugar content, reduce the seeds or seedless variety can be developed, increase fiber content.
15	*Madhuca latifolia*, Roxb.	(Sapotaceae)	"Mahua"	The fresh, as well as dry flowers, are eaten along with seed	Increase the sugar content in flower, Increase seed size and thickness of pericarp in fruit, Earliness, uniform fruit ripeness, Bush/pole plant type, per cluster fruit number increase, oil content in fruit are increase.
16	*Phoenix acaulis*, Buch.	(Palmaceae)	"Chhindi"	The ripe fruits and pulp of the rootstock are eaten by the tribal	Increase the sugar content in fruit, Increase seed size and thickness of pericarp in fruit, Earliness, uniform fruit ripeness, Bush/pole plant type, per cluster fruit number increase, decrease the size of seed or developed seedless.
17	*Solanum nigrum*, Linn.	(Solanaceae)	"Makoi"	The young leaves are cooked as a vegetable while ripe fruit is eaten (berries) as such	Increase the sugar content in fruit, decrease seed size and thickness of pericarp in fruit, Earliness, uniform fruit ripeness, Bush/pole plant type, per cluster fruit number increase, decrease the size of seed or developed seedless.
18	*Terminalia belerica*, Roxb.	(Combretaceae)	"Bahera"	The seed of the fruit is eaten	Increase seed size and thickness of pericarp, Earliness, uniform fruit ripeness, Bush/pole plant type, per cluster fruit number increase.

Conclusions

The assortment of information presented in this Distinct Story attempts to intensification to the experiments sketched above. The articles demonstrate a range of methodologies for the study of domestication, including genetics, archaeological science, and anthropology, and the promotion of new questions and hypotheses that are suitable for future supplementary testing. The market situation of current scenario creates necessities and give the solution, now day's necessity may no longer be the mother of invention. Creating a new crop variety is an exciting venture, especially if market and consumer research has revealed a need, but comprehensive solutions aren't available yet. Customers want solutions for their problems, but they can't quite identify what they need. This is where breeders come in.

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