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Traditional knowledge of botany and agriculture revealed in the *Vēda Saṃhitās*, *Brāhmaṇās*, *Araṇyakās* and *Upaniṣads*

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In the *Vēdic* scriptures, we find a large number of terms used for describing the plants and plant parts/organs, both external features and internal structures. Many of these botanical and agricultural associated terms that are currently in use in the modern botany were first revealed and comprehensively discussed in the *Vēdic* texts. The *Ṛgvēda* (RV) mentions that *Vēdic* Indians had knowledge about the food manufacture, the action of light on the process and storage of energy in plants. The classical plant morphology and classification based on various plant parts, their structures and growth is explained in detail in the *Atharvavēda* (AV) and in the *Yajurvēda* (YV) and particularly in the *Taittirīya Saṃhitā* (TS) and the *Vājasanēya Saṃhitā* (VS) and related *Brāhmaṇās*. Agricultural tools, seasons, crops, favorable crop for each season, number of crops possible for each season and so on is revealed in the *Yajurvēda* and other *Vēdic* texts. The authenticity of various botanical and agricultural terms and descriptions are discussed in detail in conjunction with the *VēdaMantras*. These are later described in *Purāṇas*, epics, as well as in several other Sanskrit texts. Descriptions and information related to plants present in the four *Vēdas* have been compared with the modern botany and the similarity has been highlighted in the article.

Keywords: Agricultural terminology, Anatomy, Botanical terminology, Classification, Plant biology, *Vēdas*

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AV - *Atharvavēda*; **BU** - *Bṛhadāraṇyakōpaniṣat*; **CU** - *Chāṃdōgyōpaniṣat*; **KYV** - *Kṛṣṇa Yajurvēda*; **KS** - *Kāṭaka Saṃhitā*; **RV** - *Ṛgvēda*; **SB** - *Śatapatha Brāhmaṇa*; **SU** - *Śvētāśvatara Upaniṣad*; **SV** - *Sāmavēda*; **SYV** - *Śukla Yajurvēda*; **TA** - *Taittirīya Āraṇyaka*; **TB** - *Taittirīya Brāhmaṇa*; **TS** - *Taittirīya Saṃhitā*; **VS** - *Vājasanēya Saṃhitā*

Science is a process of seeking the truth and for this both observational as well as experimental studies are performed. *Vēdas* consider and visualize this universe as a multi-dimensional reality and explain it in the same perspective. In this regard, *Ṛgvēda* (RV) is undoubtedly the earliest textual source of science, followed by the other three Vedas - the *Yajurvēda* (YV), the *Sāmavēda* (SV) and the *Atharvavēda* (AV). So far as the subject area of science in the Vedic literature is concerned, the list is very long and almost all aspects of modern science and technology are mentioned and discussed.

Apart from spiritual and metaphysical knowledge, *Vēdas* are treasure of scientific information. The beginning of relationship between humans and plants can be traced back to the pre-historic times. In the Vedic literature we find a large number of terms used in the description of plants and plant parts, both external features and internal structures; a definite attempt at classification of plants and evidence that use of manure and rotation of crops were practiced for the improvement of fertility of soil and nourishment of plants. *Ṛgvēda* (RV) mentions that *Vēdic* Indians had knowledge about the food manufacture, the action of light on the process and storage of energy in the body of plants. In the post-*Vedic* Indian literature there is enough evidence to show that botany developed as an independent science on which was based the science of medicine (as embodied in the *Caraka* and *Suśruta Saṃhitās*), agriculture (as embodied in the *Kṛṣi-Parāśara*) and *Arbori-Horticulture* (as illustrated in the *Upavana-vinoda* as a branch of botany). This science was known as the *Vṛkṣāyurvēda*, also compiled by Parāśara.

Vēdic botany is also a full-fledged discipline and its advocacy is the basic purpose of this research. The study of external structure of plants is known as 'Plant Morphology'. It comprises the most important aspect of the classical botany. Proper identification of higher

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plants is based upon their external structure. Identification of plants is an important aspect and is essential for their proper use, study and further research. This includes aspects of the outward appearances like shape, structure, colour, pattern and size; termed as external morphology (or Eidonomy). The study of form and structure of the internal parts like cells, tissues and organs is called Anatomy or internal morphology. Plant taxonomy is the science that finds, identifies, describes, classifies, and names the plants, thus making it one of the main branches of botany. Plant classification is the placing of known plants into groups or categories to show the relationship between them. Scientific classification follows a system of rules that standardizes the results, and groups successive categories into a hierarchy. There is a definite attempt at classification of plants in the *Vēdic* literature and evidence that use of manure and rotation of crops were practiced for the improvement of fertility of soil and nourishment of plants.In this article, the plant biology and agricultural knowledge revealed in the *Vēda Saṃhitās, Brāhmaṇās, Araṇyakās* and *Upaniṣads* are discussed and detailed along with the *Vēda Mantras*/liturgy.

Classification of Vēdic texts

The *Śr̥ti Vēdas* or the *Vēdic texts* were codified and classified into writing by the great sage, Vēda Vyasa, as the following:

1. *R̥gvēda* (RV) – wisdom of the verses
2. *Yajurvēda* (YV) – wisdom of *yajña*/sacrificial formula
3. *Sāmavēda* (SV) – wisdom of the chants, and
4. *Atharvavēda* (AV) – wisdom of *Atharvan r̥ṣis*

Vēdic texts, the *Saṃhitās, Brāhmaṇās, Āraṇyakās, and Upaniṣads*, together comprise the '*Śr̥ti*', that which was heard by the ancient *r̥ṣis*. The *Śr̥ti Vēdas* consist of four collections of *mantrās* called *Saṃhitās,* each associated with a particular *r̥ṣi/s* or the aspect of a ritual. The *Saṃhitās*, which are themselves the *Vēdas*, are the basic texts whose recitation is thought to sustain the cosmic order. Over the centuries, three kinds of additional literature were attached to each of the *Saṃhitās* - (1) the *Brāhmaṇās*, which discuss and explain how to perform the *yajñas* or rituals; (2) the *Āraṇyakās*, which are the manuscripts recited in the forests or forest treatises, giving symbolic interpretations of the *yajñas* and (3) the *Upaniṣads*, which are the philosophical writings that deal with the wisdom (*jñāna*) leading to liberation (*mokṣa*). Thus, these form the basis of an independent system, or *darśana*, called '*Vēdānta*', the "culmination of the *Vēdas*[1-4]".

Discussion

Importance of plants, trees and their by-products in Vēdas

It is found that the plants and trees have several-fold importance in the *Vēdas*. There is no ritualistic activity without usage of a plant product. The trees and plants revealed in the *Vēdas* are the key for the ritualistic activities or *yajñas*. *Yajña* is the subject matter of entire *Vēda*. Initiating any *yajña* begins primarily with the covering of the *yajñavēdi* (*yajña* alter) with the *darbha* [*Desmostachya bipinnata* (L.) Stapf], which is a grass. Also, several *yajña* implements are manufactured from the wood of specified trees, as described in the YV[4,5]. *Yajñas* and *yāgās* are the fundamental characteristics of the YV. The names of plants, trees and their products that are specifically used in the *yajñas*, y*āgās*, *hōmās* and *iṣṭis*are elaborately described in the YV *Saṃhitās* and *Brāhmaṇās*[6].

Morphology and plant classification

The *Chāṃdōgyōpaniṣat* (CU) gives the fundamental classification of the living beings based on their 'origin of life', which enumerates as follows:

| तेषां खल्वेषां भूतानां त्रीण्येव बीजानि भवन्त्याण्डजं जीवजमुद्भिज्जमिति ||

[| tēṣām khalvēṣām bhūtānām trīṇyēva bījāni bhavaṃtyāṇḍajam jīvajamudbhijjamiti ||] – **CU 6-3-1**

1. *Aṇḍa-ja* – organism born from the egg (egg-born)
2. *Jīva-ja* – organism born alive
3. *Udbhij-ja* – sprouting/originating from the ground (germinating or germination)

From the time of the RV (10-97-15) and also in the TS [4-2-6(24)], conscious effort of classification and naming of plants based on their morphological characteristics was reflected. These are broadly classified into three groups–

1. *V̥rkṣa* – Trees
2. *Ōṣadhi* – Herbs or small plants, with medicinal properties, that bear abundant flowers and fruits and wither after fruiting phase
3. *Vīrūdh* – Creepers or twines with spreading stems

References to different parts of a plant are found throughout the RV[7] and almost complete details of plants are found in the AV[8]. It can be mentioned that

the AV is perhaps the earliest recorded authority on plant morphology.

The classification of herbs and trees that are provided in the YV texts[9,10] (TS 7-3-19 and the VS 22-28) are exemplified in the subsequent sections.

Classification of herbs

| प्रस्तृणती स्तम्बिनीरेकशृङ्गाः प्रतन्वतीरोषधीरा वदामि | असुमतीः कशिडनीर्या विशाखा ह्रयामि ते वीरुधौ वैश्वदेवीरुग्राः पुरुषजीवनीः ||

[| prastṛṇatī staṃbinīrēkaśṛṃgāḥ pratanvatīrōṣadhīrā vadāmi | aśumatīḥ kaśidinīryā viśākhā hrayāmi tē vīrudhō vaiśvadēvīrugraḥ puruṣajīvanīḥ ||] – **AV 8-7-4.**

It presents an account of nine types of growth habits of plants. The classification of herbs was according to their morphological or other special properties depending upon their mode of growth. These are mentioned here below:

1. *Prastṛṇatī*– Short plants, spreading in all directions.
2. *Sthambinī* – Plants with moderate height and profusely branching.
3. *Ēkaśṛnga* – Plants with monopodial branches.
4. *Pratanvatī* – Creeping or prostrate plants.
5. *Ōṣadhī* – Medicinal annual herb.
6. *Aśumatī*– Plants with many stalks.
7. *Kaśiḍinī*– Plants having articulated stem, or knotty joints.
8. *Viśhākhā* – Plants with branches spreading in all directions.
9. *Manjarī* – Leaves or flowers in clusters.

In general, as mentioned in the TS (7-3-19), TB [3-8-17(66)] and in the VS (22-28), the following plant organs are present in the herbaceous species. The *mantra* and the classification are:

| ओषधीभ्य स्स्वाहा मूलेभ्य स्स्वाहा तूलेभ्य स्स्वाहा काण्डेभ्य स्स्वाहा वल्शेभ्य स्स्वाहा पुष्पेभ्य स्स्वाहा फलेभ्य स्स्वाहा गृहीतेभ्य स्स्वाहा गृहीतेभ्य स्स्वाहा वपन्नेभ्य स्स्वाहा शयानेभ्य स्स्वाहा सर्वस्मैस्वाहा ||

[| ōṣadhībhya ssvāhā mūlēbhya ssvāhā tulēbhya ssvāhā kaṇḍēbhya ssvāhā valśēbhya ssvāhā puṣpēbhya ssvāhā phalēbhya ssvāhā gr̥hītēbhya ssvāhā gr̥hītēbhya ssvāhā vapannēbhya ssvāhā śayānēbhya ssvāhā sarvasmai ssvāhā ||] – **TS 7-3-19.**

1. *Ōṣadhībhya*–Herbs
2. *Mūla*–Root
3. *Tūla*–Panicle
4. *Kāṇḍa* –Stem
5. *Valśa*–Twig
6. *Puṣpa*–Flower
7. *Phala*–Fruit

Classification of trees

| वनस्पतिभ्यः स्वाहा मूलेभ्यः स्वाहा तूलेभ्यः स्वाहा स्कन्धोभ्यः स्वाहा शाखाभ्यः स्वाहा पर्णेभ्यः स्वाहा पुष्पेभ्यः स्वाहा फलेभ्यः स्वाहा ....||

[| vanaspatibhya ssvāhā mūlēbhya ssvāhā tūlēbhya ssvāhā skaṃdhōbhya ssvāhā śākhābhya ssvāhā parṇēbhya ssvāhā puśhapēbhya ssvāhā phalēbhya ssvāhā ..... ||] – **TS 7-3-20.**

1.	*Vanaspati*	–	Trees/Forests
2.	*Mūla*	–	Root
3.	*Tūla*	–	Panicle
4.	*Skandha*	–	Corona
5.	*Śākhā*	–	Branches
6.	*Parṇa*	–	Leaves
7.	*Puṣpa*	–	Flower
8.	*Phala*	–	Fruit

In the classification of trees, it can be observed that the mantra begins with the term '*Vanaspati*'. It means forests or trees, as they produce wood. Also, the trees have '*Skandha*' (crown), meaning corona. Trees have more number of leaves when compared to herbaceous plants. Hence, the term '*Parṇa*' – meaning leaves, are present.

In another simple plant classification, the YV (TS 1-3-5) classified trees into two categories. They are called (1) *yūpyamulu* and (2) *ayūpyamulu*. The *yūpas* (sacrificial post) are made from '*yūpyamulu*'[4], which are the trees of *aśvat'tha* [*Ficus religiosa* L.], *nyagrōdha* [*Ficus benghalensis* L.], *uduṃbara* [*Ficus racemosa* L.], *palāśa* [*Butea monosperma* (Lam.) Taubert], *bilva* [*Aegle marmelos* (L.) Correa], *khādira* [*Acacia catechu* (L.f.) Willd.], *rājjudāla* [*Cordia dichotoma* L.] and *pūtu-dru* [*Cedrus deodara* (Roxb. ex D. Don) G. Don] are used to tie animals in *yajña*. The rest of the trees are called as '*ayūpyamulu*'[4].

Classification of roots

Various types of root forms (Fig. 1 a-f) have been described in the *Vēdic* texts and later in some Sanskrit texts too, which correspond to modern botanical terms. The following are some important terms:

1. *Sthūlamūla*–Tap root - thick and fleshy single root with secondary roots, e.g.: all dicotyledon species (Fig. 1 a)
2. *Bahumūli*–Adventitious roots - many roots originating from one point, e.g.: all grass species (Fig. 1 b)
3. *Jaṭamūla*–Fasciculate roots, e.g.: *Dahlia pinnata* Cav. (Fig. 1 c)
4. *Sthūlamūla*–Modified roots - fusiform roots, e.g.: *Raphanus sativus*Linn. (radish) (Fig. 1 d)

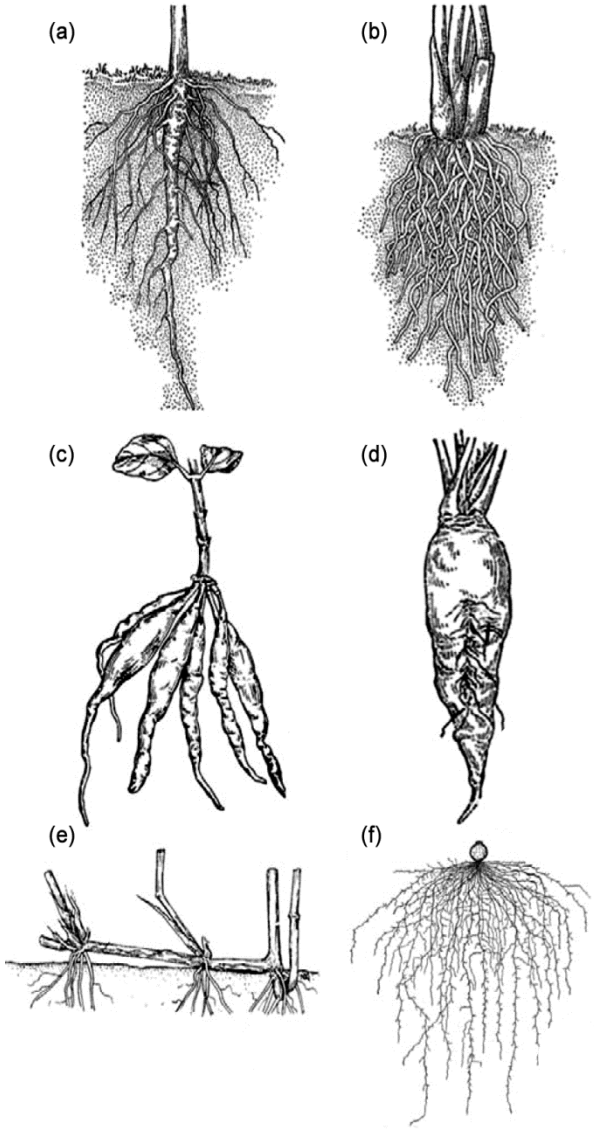

Fig. 1 — Root types - (a) *Sthūlamūla* - tap root - e.g. all dicotyledon species, (b) *Bahumūli* - fibrous roots - e.g. all grass species, (c) Jaṭamūla - fasciculate roots - e.g. *Dahlia pinnata* Cav., (d) *Sthūlamūla* - root modification - fusiform roots - e.g. *Raphanus sativus* Linn. (radish), (e) *Śākha-sipha* - branched - fibrous roots - e.g. *Zingiber officinale* Roscoe (ginger) and (f) *Sūkṣmamūla* - thin roots - e.g. *Allium cepa* Linn. (onion)

5. *Sākhā-sipha* –Adventitious roots -roots originating from nodal branches, e.g.: *Zingiber officinale* Roscoe (ginger) (Fig. 1 e)
6. *Sūkṣmamūla* –Thin roots or fibrous roots, e.g. *Allium cepa* Linn. (onion) (Fig. 1 f)
7. *Kṛṣṇamūli*–Black coloured roots.
8. *Swētamūli*–White coloured roots, e.g.: *Asparagus officinalis* Linn.
9. *Tripadi*–Plant with three main roots.

Classification of leaves

Some Sanskrit terms from the *Vēdic* literature indicate various types of leaves (Fig. 2 a-f). These terms correspond to modern botanical terms. They are –

1. *Ēkapatra*–Simple leaf (Fig. 2 a)
2. *Bahupatra*–Compound leaf (Fig. 2 b)
3. *Savrinta Parṇa* –Petiolate leaf (Fig. 2 c)
4. *Avrintaka Parṇa*–Sessile leaf (Fig. 2 d)
5. *Aśvaparṇi*–Horse ear shaped leaf, e.g.: *Shorea robusta* Roth (Fig. 2 e)
6. *Mūṣikaparṇi*–Mouse shaped leaf, e.g.: *Salvinia molesta* D. Mitch. (Fig. 2 f)

Botanical terminology

Several botanical terms are described in all the four *Vēdas* and particularly in the *Yajurvēda* (YV). The TS[11,12] and the VS[13] describe and explain that plants comprise of various parts. The TS classifies the plant kingdom into several classes based on their form and growth. These botanical terms can be identified with the modern botany. Hence, the *ṛṣis*, the ancient scientists, realized the importance of classifying the plants according to their vegetative and reproductive properties, similar to that of the present-day modern classifications of the plant kingdom by Carolus Linnaeus and others. Another interesting feature noticed in the VS, TB and AV is the description of an entire region by the type of plants growing in that area, e.g. *naḍvala* (a place abounding in reeds), *śipālya* (a region where the plant *śipala* grows).

A*sūkta* in the AV (8-7-12) elaborately describes various plant parts and its medicinal values, which can remove many ailments in human beings. These terms are now being widely used in the *Āyurvēdic* treatments. They are as follows:

। मधु॒म॒न्मू॒लं मधु॒म॒दग्र॑मासा॒ मधु॒म॒न्मध्य॑ वी॒रुधा॑ बभूव ।
मधु॒मत्प॒र्ण मधु॒म॒त्पु॒ष्प॑मासा॒ मधो॒: संभ॑क्ता अ॒मृत॑स्य भ॒क्षो घृ॒तमन्न॑ दुहु॒ता॒ गोपु॑रोगवम् ॥

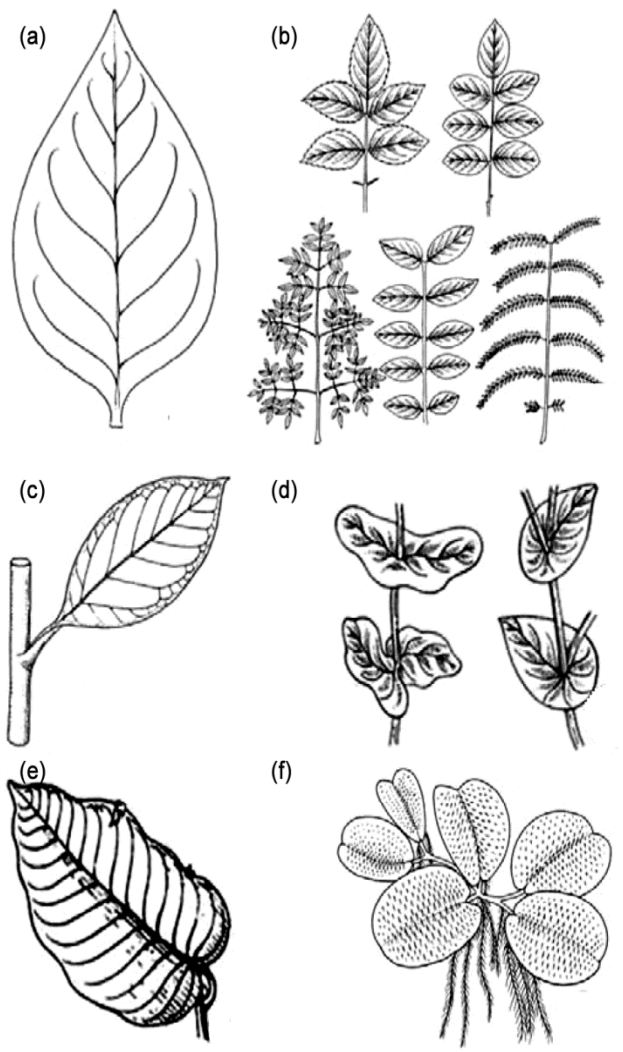

Fig. 2 — Leaf types - (a) *Ēkapatra* - simple (single) leaf, (b) *Bahupatra* - compound leaves, (c) *Savrinta Parṇa* - petiolate leaf, (d) *Avrintaka Parṇa* - sessile leaf, (e) *Aśvaparṇi* - horse-ear shaped leaf - e.g. *Shorea robusta* Roth and (f) Mūṣikaparṇi - mouse-shaped leaf - e.g. *Salvinia molesta* D. Mitch.

[| madhumanmūlaṃ madhumadagramāsaṃ madhumanmadhyaṃ vīrudhāṃ babhūva |

madhumatparṇaṃ madhumatpuṣpamāsāṃ madhōḥ saṃbhaktā amṛtasya bhakṣō ghṛtamannaṃ duhrutāṃ gōpurōjavam ||] – **AV 8-7-12.**

1. *Mūlam* –Root
2. *Agrabhag*–Shoot apex or shoot tip
3. *Madhyabhag*–Stem or trunk
4. *Parṇa* –Leaf or leaves
5. *Pushpam*–Flowers of medicinal plants contain
6. *Amṛtasya*–Sweet content

Ōṣadhi is one of the classifications of plants according to their stature. It is an annual plant or herb, one that dies immediately after it produces seeds. It is also defined as a plant or herb that lasts for one year or a season, e.g. *apāmārga* (*Achyranthes aspera* L.). It is also known as a medicinal plant herb, e.g. a*śvagaṃdha* [*Withania somnifera* (L.) Dunal]. In the RV, the term '*ōṣadhi'* is personified as divine and a long hymn is devoted to its praise mainly with reference to the healing powers. Also, the RV often refers to *soma* as the king of the plant-world. *Ōṣadhi* is employed in opposition to *vīrudh* [e.g. *Pāṭhā*, *Cissampelos pareira* L.] to denote as possessing a healing power or some other quality useful to men, while *vīrudh* is rather a generic term for minor vegetable growths, but sometimes when occurring beside *ōṣadhi*, it signifies those plants which do not possess medicinal properties. Here below is the *mantra* that is mentioned in the TS.

[| ओषं॑धयो वी॒रुधं॑ ||] [ōṣadhayō vīrudha ||] – TS 2-5-3(2)

Vṛkṣa refers to a 'tree'. It is a common term mentioned in the RV (1-164-20, 1-164-22, 2-14-2, 2-14-39, 4-20-5, 5-78-6); AV (1-14-1, 2-12-3, 6-45-1, 12-1-27, 12-15-1); TS [4-5-2(2), 4-5-2(9), 4-5-8(7), 4-5-11(5)]; and VS (16-20, 16-22, 16-28). It is one of the classifications of plants according to their stature. *Vṛkṣas* are plants that have trunks and branches and bear flowers and fruits, such as *aśvat'tha* (*Ficus religiosa* L.). The term is used throughout the *Āyurvēdic* literature such as the *Suśruta-saṃhitā* and the *Caraka-saṃhitā*.

Valśa denotes a 'twig' both for herbs and trees. It is usually present in compounds as *Śata-valśa*, 'having hundred twigs' [RV 3-8-2; RV 7-33-9; TS 1-3-5(9), *Kāṭaka Saṃhitā*, KS 3-2] or *Sahasra-valśa*, 'having thousands of twigs', which is applied metaphorically of 'offspring' [TS 1-3-5(9) and KS 3-2].

| पृथि॒व्या सं भ॑व॒ वन॑स्पते श॒तव॑ल्शो॒ वि रो॑ह स॒हस्र॑वल्शा॒ वि व॒यग्म् रु॑हेम॒ यं त्वा॒ऽयग्ग् स्वधि॑ति॒स्तेति॑जानः प्रणि॒नाय॑ मह॒ते सौभ॑गा॒याऽच्छि॑न्नो॒ रायः॑ सु॒वीरः॑ ||

[| prthivyā sam bhava vanaspatē śatavalśō vi rōha sahasravalśā vi vayagum ruhēma yam tvāyagg svadhitistētijānaḥ praṇināya mahatē saubhagāyācchinnō rāya ssuvīraḥ ||] – **TS 1-3-5(9)**

Kṛmuka is mentioned in the KS (19-10) and in the*Śatapatha Brāhmaṇa*[SB 6-6-2(2)] as a species of wood used as a*samidh* (fuel stick).The name *kṛmuka*

mentioned in the TS [5-1-9(49)] and in the TB [1-4-7(3)] as 'wood' appears to be a variant form as described below:

| स क्रुमुकं प्राविशत्क्रुमुकमव दधाति ||

[| sa krumukaṃ prāviśat krumukamava dadhāti ||] – **TS 5-1-9(49)**

Vanaspati means the 'lord of the forest' and primarily denotes 'forest tree' as described in the RV (1-166-5, 3-34-10 and 5-7-4). In the TS [4-2-9(3), 6-2-8(4) and 7-3-20] and in the AV (9-3-2) it is described as 'post' or 'pole'. In some passages of RV (2-37-3, 3-53-20 and 6-47-26) it can be inferred either to a part of the chariot or to the chariot as a whole. It can also mean a 'wooden drum' and a 'wooden amulet' as indicated in the VS (9-12) and in the AV (12-3-15), while in some passages of RV (1-91-6) and in the VS (10-23) it denotes the plant *par excellence*, *soma*. It is one of the classifications of plants according to their stature. *Vanaspatis* are trees that bear flowers and fruitsand possess woody trunks, such as the *uduṃbara* (*Ficus racemosa* L.). This is used throughout the *Āyurvēdic* literature such as the *Suśruta-saṃhitā* and the *Caraka-saṃhitā*.

Dāru means 'wood,' is frequently mentioned in the RV (6-3-4), AV (10-4-3) and TS [4-1-10(1)] denoting amongst other things, the pole of a chariot (RV 10-102-8), logs for fuel (RV 8-102-20), wooden parts of a car [SB 6-6-2(14)], possibly wooden stocks (AV) and so forth.*Dāru* is another name for *devadāru*, which is a Sanskrit word referring to the Himalayan cedar [*Cedrus deodara* (Roxb. ex D. Don) G. Don]belonging to the Pinaceae family. It is classified as a medicinal plant in the system of *Āyurvēda* and is used throughout its literature such as the *Suśruta-saṃhita* and the *Caraka-saṃhitā*.

Ku-muda is the name of a plant mentioned with other water plants in one of the passages of the AV (4-34-5). It is the white water-lily, *kyāmbu* (*Nymphaea pubescens* Willd.), being the name of that plant in the post-*Vēdic* Sanskrit too. *Mulālin* (masculine) and *mulālī* (feminine), is the name of the edible part of the lotus, in the AV and in the VS 16-10.

Sreka-parṇa is a name mentioned in the *Brāhmaṇās* and seems to mean the 'oleander leaf' mentioned in the TB [3-6-6(3)] and AB (2-6-15).

Apsuja means water-born, is mentioned in the TS [5-3-12(2)] and in the TB [(3-8-4(30)]. Examples in this category are the *puṣkara parṇa* (*Nymphaea nouchali* N. Burman), *avakā* [*Blyxa octandra* (Roxb.) Planch.ex Thwaites], *kyāmbu* (*Nymphaea pubescens* Willd.), *vetasa* (*Calamus rotang* L.) and others. The word *vetasa* is used throughout the *Āyurvēdic* literature such as the *Caraka-saṃhitā* and the *Suśruta-saṃhitā*.

Tokman is designated in the RV (10-62-8) and later in the VS (19-13-81, 21-20-42), KS (12-2), MS (3-2-9), TB (2-6-4) and AB (8-5) as the green shoots of any species of a grain plant. In the AB (8-16), thereference is made to the shoots of rice (*vrīhi*), large rice (*mahāvrīhi*), panic seed (*priyaṅgu*), and barley (*yava*).

***Botanical terminology in* Śrī Rudram**

The *Yajurvēda* hymns that have gained particular importance are the '*Rudra Namakaṁ* (TS 4-5)' and the '*Rudra Camakaṁ* (TS 4-7)' which constitute the '*Śrī Rudram*'. The *Rudra Namaka* and the *Rudra Camaka mantras* reveal many botanical and agricultural terminologies, names of plants and trees[14].These terms, mentioned in the *Śrī Rudra mantras* (TS 4-5, TS 4-7 and VS 16), are explained in detail in comparison with the modern botanical and agricultural terminologies and enlightened here.

- ***Vṛkṣa*** – Tree/s [TS 4-5-2(2), TS 4-5-2(9), TS 4-5-8(7), [TS 4-5-11(5)].
- ***Harikēśa***– Green coloured hair-like structures. It is botanically termed as 'trichomes' on the leaves and stem [TS 4-5-2(2), TS 4-5-8(7)].
- ***Saspiñjarāya***– Tender grass in red and yellow colours [TS 4-5-2(3), [TS 4-5-11(5)].
- ***Rōhitāya***– Grass in red or ruby colour [TS 4-5-2(9)]
- ***Ōṣadhi***– An annual plant/herb with medicinal properties [TS 4-5-2(11)].
- ***Budhniyāya***– The buttress roots of huge trees or the aerial roots of huge *Ficus* trees [TS 4-5-6(4)].
- ***Vanyāya***– Forests [TS 4-5-6(9)].
- ***Kakṣyāya***– Trees that are not having a trunk. This means the shrubs, plants and creepers [TS 4-5-6(9)].
- ***Śaṣpa***–Just-born *darbha* grass (*Desmostachya bipinnata* (L.) Stapf) growing on the banks of the river
- Ganga [TS 4-5-8(16); VS 21-29; SB 12-7-2(8), SB 12-9-1(2); AB 8-5-3, AB 8-8-4].
- **Kātyāya**– Creepers with thorns [TS 4-5-9(6)].
- ***Śśuṣkyāya***– Dried tree wood [TS 4-5-9(9)].

- ***Harityāya***– Moist green tree wood [TS 4-5-9(9)].
- ***Parṇyāya***– Green leaves [TS 4-5-9(12)].
- ***Parṇaśadyāya***– Dried leaves [TS 4-5-9(12)].
- ***Kūyavā***– *Yava* (*Hordeum vulgare* Linn.) of not good quality (TS 4-7-4).
- ***Kṛṣṭapacyam***– One time ploughed field (TS 4-7-5).
- ***Akṛṣṭapacyam***– Unploughed field (TS 4-7-5).
- ***Annam***– Reputed food that is eatable (TS 4-7-4).
- ***Akṣut***– Relief from hunger (TS 4-7-4).

[The below-mentioned seven terms indicate the progressive increase in the quality of food grains; the second term indicating a higher growth than the first and so on, the seventh term indicating the highest growth.]

- ***Vibhu***– Superior grains (TS 4-7-4).
- ***Prabhu***– More superior grains (TS 4-7-4).
- ***Bahu***– Much Superior grains (TS 4-7-4).
- ***Bhūya***– Much more superior grains (TS 4-7-4).
- ***Pūrṇam***– Filled grains (TS 4-7-4).
- ***Pūrṇataram***– Fine-filled grains (TS 4-7-4).
- ***Akṣiti***– Not destructed grains (TS 4-7-4).

Plant anatomy

Although anatomy (study of internal tissues and organs) of higher plants became distinct only after the invention of microscopes, it is interesting to trace some highly remarkable anatomy revealed in the *Vēdic* texts without using a microscope.

The TS separates the outer part of the plants into two layers, the outer *valka* and the inner *valkala.* It is clearly noticed that the stem of a plant is divided into an epidermis (*tvac*, the outer layer) and the internal tissues namely, the bast or softer tissue (*śakara*), fibrous tissue (*kinara*) within the bast, the inner wood (*dīru*) and the pith (*majjī*) embedded in the wood.

The BU, while comparing a human being with a tree, provides information about the internal structure and organs of the latter as follows:

| यथा वृक्षो वनस्पतिः तथैव पुरुषोमृश | तस्य लोमानि पर्णानि त्वगस्योत्पाटिका बहिः || त्वचं एवस्य रुधिरं प्रस्यन्दि त्वक् उत्पटः | तस्माद् तदावृण्णात् प्रैति रसो वृक्षादिवाहतात् || माग्ँसान्यस्य शकराणि किनाटग्ँ स्नाव तत्स्थिरम् | अस्थीन्यन्तरतो दारुणि मज्जा मज्जोपमा कृता ||

[| yathā vṛkṣō vanaspatiḥ tathaīva puruṣōmṛśa | tasya lōmāni parnāni tvagasyōtpātīkā bahiḥ | tvak ēvasya rudhiram prasyandi tvak utpaṭaḥ | tasmāttadātṛṇṇāt praiti rasō vṛkṣādivāhatāt || māguṃsānyasya śakarāṇi kināṭagum snāva tatsthiram | asthīnyantaratō dāruṇi majjā majjōpamā kṛtā ||] – **BU 3-9-28 (1-3).**

*"A man is indeed like a mighty tree; his hairs are his leaves and his skin is its outer bark. The blood flows from the skin (of man), so does the sap from the skin (of the tree). Thus blood flows from a wounded man in the same manner as sap from a tree that is struck. His flesh (corresponds to what is) within the inner bark, his nerves are as tough as the inner fibers (of the tree). His bones lie behind his flesh as the wood lies behind the soft tissue (*śakara*). The marrow (of the human bone) resembles the pith (of the tree)".* It is clearly noticed that a plant is divided internally into an epidermis (*tvac*), a bast or softer tissue (*śakara*), fibrous tissue (*kinara*) within the bast, the inner wood (*dīru*) and the pith (*majjī*) embedded in the wood.

Tvac or Skin –It corresponds to epidermis or epiblema of stem and root, respectively.

Mamsa–Soft tissue. This region corresponds to cortex, which is mainly composed of soft tissue parenchyma.

Asthi or wood–This region is described in modern botany as primary and secondary xylem, which constitutes the mechanical strength providing part.

Majja This term refer to 'pith' in modern botany, which is the central portion of stem and root responsible for storage of various materials.

Snyau - Fibrous tissue This term in *Vēdic* literature is similar to sclerenchymatous fibers found among xylem and

phloem tissue. This portion is also responsible for providing mechanical strength to plants.

Plant physiology

Plant physiology is the study of the vital processes of plant life. It is a sub-discipline of botany concerned with the functioning of plants. This biological science is concerned with the general patterns governing the life processes of plants. Plant physiology studies the ways in which plants absorb minerals and water, grow and develop, flower and bear fruit. It also deals with mineral nutrition, photosynthesis, respiration, and biosynthesis and the accumulation of substances which together enable plants to grow and reproduce themselves. Study of plant physiology has been a complex aspect of botany and various modern and sophisticated techniques are utilized for knowing the facts. But the survey of *Vēdic* literature reveals that the sages of those days had adequate scientific

knowledge about the physiological activities of plants which they have mentioned at various places in *Vēdas* and the related literature. A few glimpses of such literary sections are enumerated here:

The RV mentions that sun is the source of energy and plants utilize the solar radiation for supporting their own life.

| उप॑ नः॒ सव॒ना ग॑हि॒ सोम॑स्य सोमपाः पिब | गो॒दा इद्रे॒वतो॒ मद॑ः ||]

[| upa naḥ savanā gahi sōmasya sōmapāḥ piba | gōdā idrēvatō madaḥ ||] – **RV 1-4-2.**

The *Śvētāśvatara Upaniṣad* (SU) tells that the *Rudra* has created all living beings with the help of sunlight. Sun is also essential for sustenance of life.

| यो देवानां प्रभवश्चोद्भवश्च विश्वाधिपो रुद्रो महर्षिः | हिरण्यगर्भं जनयामास पूर्वं स नो बुध्या शुभया संयुनक्तु ||]

[| yō dēvānāṃ prabhavaścōdbhavaśca viśvādhipō rudrō maharṣiḥ | hiraṇyagarbhaṃ janayāmāsa pūrvaṃ sa nō budhyā śubhayā saṃyunaktu ||] – **SU 3-4.**

The above mentioned *mantra*clearly reflects the knowledge of photosynthesis present in the *Vēdic* period.

It is surprising to note that some verses of the *Atharvashira Upaniṣad* (AU) and the SU indicate that sages of that period were having sufficient knowledge of biochemical activities of plant cells leading to synthesis of various compounds essential for life.

| वलग्रमत्रम् हृदयस्थ मध्ये | विश्वं देवं जत्रुपं वरेण्यम् ||

[| valagramatram hṛdayastha madhyē | viśvaṃ dēvaṃ jatrupaṃ varēṇyam ||] – **AU 5.**

The following verse of SU recognizes cells as centre of various chemical activities and changes.It clearly indicates knowledge of biochemistry in those days.

| वलग्र शतभागस्य शतधा कल्पितस्य च | भागो जीवः स विज्ञेयः स चानन्त्यायकल्पते ||

[| valagra śatabhāgasya śatadhā kalpitasya ca | bhāgō jīvaḥ sa vijñēyaḥ sa cānaṃtyāyakalpatē ||] – **SU 5-9.**

One of the *sūktas* in the RV provides a scientific description of absorption of water by plants and ascent of sap. Release of water from plants in the form of vapour is termed as transpiration, which is a physiological process essential for growth and development of plants. Air plays an important role in this process. It removes water vapour from around the plants so that the atmosphere around remains dries enough to receive water vapour. These facts are remarkably depicted in the RV.

| अ॒प्सु मे॒ सोमो॑ अब्रवीद॒न्तर्विश्वा॑नि भेष॒जा | अ॒ग्निं च॑ वि॒श्वश॑म्भुव॒मापं॑श्च वि॒श्वभे॑षजीः ||

[| apsu mē sōmō abravīdaṃtarviśvāni bhēṣajā | agniṃ ca viśvaśaṃbhuvamāpaśca viśvabhēṣajīḥ ||] – **RV 1-23-20.**

The king of plants, the *soma*, takes up water and converts it into medicine, which is highly useful for man. Indications of upward movement of water and minerals against the force of gravity are also available in the *Bṛhat-Jabala Upaniṣad*. Here '*Bhṛgu'* is considered as pulling power of materials.

| वृध्वक्षतिमयः सोम अधः शक्तिमयो अनलः शिवश्चोर्ध्वमयः शक्तिरुर्ध्व शक्तिमयः शिवः तदित्यं शिवशक्तिभ्यां नर्यप्तमिः किन्चन् ||

[| vṛdhvakṣatimayaḥ sōma adhaḥ śaktimayō analaḥ śivascōrdhvamayaḥ śaktirurdhva śaktimayaḥ śivaḥ tadityaṃ śivaśaktibhyāṃ naryaptamiḥ kincan ||] – **BJU 1-5-9.**

The manufacture and storage of food in plants can be obtained from the references mentioned in the MS (2-4-8), KS (11-10) and BU (6-4-1), where water is regarded as the essence of the earth (*pṛthivyāḥ āpaḥ*, **पृथिव्याः आप**:), herbs as the essence of water (*apāmōṣadhyah*, **अपामोषध्यः**), flowers as the essence of herbs (*ōṣadhīnāṁ puṣpāṇi*, **ओषधीनां पुष्पाणि**) and fruits as the essence of flowers (*puṣpānām phalāni*, **पुष्पानां फलानि**).

Plants need air to stay alive. Plant leaves use carbon dioxide from the air to make sugar and starch to use as food. Another plant part that needs air is the roots. Plant roots need oxygen to stay healthy and to perform the absorption of water and nutrients for the growth of plant. Air gently touches the plants and this act help plants to grow properly. Some of the *sūktas* in the RV indicate that the growth and development of plants were known in the *Vēdic* period too. Various modes of plant growth have *mantra*-reference in the *Vēdic* literature. Here below are some examples on the growth and development of plants revealed in the *Vēdas*.

| उ॒त स्म॑ ते वनस्पते॒ वातो॒ वि वा॒त्यग्र॒मित् | अथो॒ इंद्रा॑य॒ पात॑वे सु॒नु सोम॑मुलूखल ||

[| uta sma tē vanaspatē vātō vi vātygramit | athō indrāya pātavē sunu sōmamulūkhala ||] – **RV 1-28-6.**

In the RV, it is mentioned that the man develops with knowledge, and in the same way trees grow with the help of nutrients.

| उच्छ्रयस्व वनस्पते वर्ष्मन्पृथिव्या अधि | सुमितीमीयमानो वर्चो धा यज्ञवाहसे ||

[| ucchrayasva vanaspatē varṣmaṃpṛthivya adhi | sumitī mīyamānō varcōdhā yajñavāhasē ||] – **RV 3-8-3.**

In some of the verses of RV, physiological process of seed germination has been described in a scientifically appropriate way.

| वनस्पते शतवल्शो वि रोह सहस्रवल्शा वि वयं रुहेम | यं त्वामयं स्वधितिस्तेजमानः प्रणिनाय महते सौभगाय ||

[| vanaspatē śatavalśō vi rōha sahasravalśā vi vayaṃ ruhēma | yaṃ tvāmayam svadhitistējamānaḥ praṇināya mahatē saubhagāya ||] – **RV 3-8-11.**

It is described in the RV that the healthy seeds germinate in agriculture fields and yield grains. And also the viable seeds are capable of germination again and should be preserved for future prosperity.

| तस्मिन्ना वेशया गिरो य एकश्चर्षणीनाम् | अनु स्वधा यमुप्यते यवं न चर्कृषदवृषा ||

[| tasminnā vēśayā girō ya ēkaścarṣaṇīnām | anu svadhā yamupyatē yavaṃ na carkṛṣadvṛṣā ||] – **RV 1-176-2**.

Agricultural Terminology

Several agricultural terms those are in use in the present day agriculture are described in the *Vēdas*. The entire agricultural operations were given a spiritual domination. The agricultural implements, the seasons, the suitability of crops per season and cycle/s of crops per season are well mentioned in the YV and other *Vēdas*. Also, the soil, land, manure and manuring, crop husbandry inclusive of plant protection measures, irrigation system, animal husbandry and meteorological observations in relation to crop prospects are described in the RV and other *Vēdic* texts[15].

Kṛṣi, i.e., 'ploughing', an act of cultivation of soil, was known to the Indians since ancient times as indicated with the terms ***yavaṃkṛṣ*** and ***sasya*** in the RV (3-52-13, 1-23-15, 10-34-13, 10-117-7, 10-146-6 and 10-101-4). In the AV (8-10-24), the words ***pṛthīvainya*** refers to the origination of ploughing. The word ***kṛṣi*** is repeatedly mentioned in the *Saṃhitās* (AV 2-4-5, AV 8-2-19, AV 10-6-12, AV 12-2-27; TS 7-1-2; MS 1-2-2, MS 3-6-8; VS 4-10, VS 10-22, VS 14-19, VS 14-20) and as well as in the *Brāhmaṇas* [SB 7-2-2(7), SB 8-6-2(2);TB 3-1-2(16), TB 3-1-5]. The word ***kārṣīvaṇa*** denotes a 'plougher' in the AV (6-116-1). The other agricultural terms such as ***kṛṣṭapacyam*** indicate that the cereals (grain plants) grown in one time ploughed field (TS 4-7-5) and the ***akṛṣṭapacyam*** designate that the grain plants grown in an unploughed field (TS 4-7-5).

Kṣetrapati, the 'presiding deity of agriculture' indicating either *Rudra* or *Agni*, supervising all the agricultural activities described in one entire *sūkta* of the RV (4-57-1 to 8).

Sīra, 'plough', is mentioned in the RV (4-57-8, 10-101-3 and 10-101-4) and often in the later *Saṃhitās* (AV 6-30-1, AV 6-91-1, AV 8-9-16; VS 18-7; MS 2-2-4) and *Brāhmaṇas* [TB 1-7-1(2), TB 2-5-8(12)]. It was large and heavy, as described by the fact that six oxen (AV 6-91-1, AV 8-9-16; TS 5-2-5(2);KS 15-2; SB 7-2-2(6), SB 13-8-2(6)) or eight oxen (AV 6-91-1) or twelve oxen (TS 1-8-7(1), TS 5-2-5(2); KS 15-2; MS 2-6-2) or even twenty-four oxen (KS 15-2) were used in dragging it[16].

***Tṛṇa*,** 'grass'[16], is often mentioned in the RV (1-161-1, 1-162-8 and 10-102-10), AB (3-22 and 8-24) and later in the AV (2-30-1 and 4-54-1). It was used to thatch the roof of a house or hut (AV 3-12-5 and AV 9-3-4).

Śaṣpa is mentioned in the YV *Saṃhitās* [TS 4-5-8(16) and VS 21-29] and in RV *Brāhmaṇa* (AB 8-5-3 and AB 8-8-4**)**, YV *Brāhmaṇa* [SB 12-7-2(8) and SB 12-9-1(2)]. It is explained in the TS commentaries[11,12] that the term *śaṣpa* means a just born *darbha* grass [*Desmostachya bipinnata* (L.) Stapf] growing on the banks of the river Ganga. Colloquially, it also denotes 'young or a sprouting grass'[16].

Sasa in the RV (1-51-3 and 10-79-3) denotes a 'herb' or 'grass'[15]. The word is also applied to the *soma* plant mentioned in the RV (3-5-6 and 4-5-7) and also as a 'sacrificial straw', in the RV (5-21-4).

Barhis, synonymous to *darbha*, is found repeatedly in the RV (1-63-7, 1-108-4 and 3-4-4) and later in the TS (6-2-4(5) and in the VS (2-1) denoting the litter of grass strewn on the sacrificial ground on which the deities are summoned to seat themselves.

Dhānya denotes 'grain' in general and is found in the RV (6-13-4), AV [3-24-2(4), 5-29-7 and 6-50-1], KB (9-8) and SVB (5-5).

Grāmyāṇi refers to the ten cultivated grains, as mentioned in the BU (6-3-13), which are - (1) *vrīhi* (rice), (2) *yava* (barley), (3) *tila* (sesame), (4) *māsha* (black gram), (5) *aṇu* (panic grass), (6) *priyaṅgu* (Indian millet), (7) *gōdhūmā* (wheat), (8) *masūrā* (lentil), (9) *khalva* (bengal gram) and (10) *kulā* (wild gram). Men are referred to as ***dhānya-kṛt*** (winnower or purifying grain) in the RV (10-94-13).

Sasya in the AV (7-2-1 and 8-10-24), TS [3-4-3(3), 5-1-7(3) and 7-5-20(1)] and MS (4-2-2) is generally referred to any kind of cereal crop. Contextually, it may also mean as 'harvest'. ***Lavana*** in the *Nirukta* (ii. 2) text denotes the 'mowing' or 'reaping' of any cereal crop. ***Śarāva*** is a measure of cereal grain in the *Brāhmaṇas*. TB [1-3-4 (5); 1-3-6 (8)] and SB [5-1-4 (12)] mentions it as *saptadaśa-śarāva*.

Bīja denotes 'seed' and the operation of sowing seed, ***vap***, is referred several times in the RV (10-94-13 and 10-101-3), later in the TS (7-5-20), AV (10-6-33) and SB [7-2-2 (4)].

Agriculture seasons

The seasons for agriculture are briefly summed up in a passage of the TS (Table 1), along with the respective crops that have to be sown and are mentioned in the *mantra* below:

Table 1 — List of botanical and agricultural terminologies revealed in the *Vēdic* Texts

***Vēdic* Sanskrit Name**	**Botanical Form**	**Vēda Reference**
		Botanical Terminology
Agrabhag	Apex	AV 8-7-12
Apsuja	Water-born	TS 5-3-12(2); TB 3-8-4(3)
Kāṇḍa	Stem	TS 7-3-19, TS 7-3-20; VS 22-28
Madhyabhag	Trunk	AV 8-7-12
Mūla	Root	TS 7-3-19, TS 7-3-20; TB 3-8-17(66); VS 22-28; AV 8-7-12
Ōṣadhi	Herb or medicinal plant	TS 4-2-6(24), TS 4-2-6(28), TS 4-5-2(11), TS 7-3-19, TS 7-3-20; TB 3-8-17(66); VS 22-28
Parṇa	Leaf or leaves	TS 7-3-19, TS 7-3-20; VS 22-28; AV 8-7-12
Phala	Fruit	TS 7-3-19, TS 7-3-20; TB 3-8-17(66); VS 22-28
Puṣpa	Flower	TS 7-3-19, TS 7-3-20; TB 3-8-17(66); VS 22-28; AV 8-7-12
Śākha	Branch	TS 7-3-19, TS 7-3-20; VS 22-28
Skanda	Crown	TS 7-3-19, TS 7-3-20; VS 22-28
Tṛṇa	Grass	RV 1-161-1, RV 1-162-8, RV 10-102-10; AB 3-22, AB 8-24; AV 2-30-1, AV 3-12-5, AV 4-54-1, AV 9-3-4
Tūla	Shoot	TS 7-3-19, TS 7-3-20; VS 22-28
Valaśa	Twig	TS 7-3-19, TS 7-3-20; VS 22-28
Vīrūdh	Creeper/s	TS 4-2-6(24)
Vṛkṣa	Tree/s	RV (1-164-20, 1-164-22, 2-14-2, 2-14-39, 4-20-5, 5-78-6); AV (1-14-1, 2-12-3, 6-45-1, 12-1-27, 12-15-1); TS [4-5-2(2), 4-5-2(9), 4-5-8(7), 4-5-11(5)]; VS (16-20, 16-22, 16-28)
Barhis	Sacred grass	RV 1-63-7, RV 1-108-4; RV 3-4-4; TS 6-2-4(5); VS 2-1, VS 18-1
Budhniyāya	Buttress roots	TS 4-5-6(4)
Harikēśa	Trichomes	TS 4-5-2(2), TS 4-5-8(7)
Harityāya	Moist green tree wood	TS 4-5-9(9)
Kakṣyāya	Shrubs, creepers, plants	TS 4-5-6(9)
Parṇyāya	Green leaves	TS 4-5-9(12)
Parṇaśadyāya	Dried leaves	TS 4-5-9(12)
Rōhitāya	Red or ruby colour	TS 4-5-2(9)
Śaṣpa	Sprouting grass	TS 4-7-8; VS 19-13-81, VS 21-29; SB 12-7-2(8), SB 12-9-1(2); AB 8-5-3, AB 8-8-4
Sasa	Herb or grass	RV 1-51-3, RV 3-5-6, RV 4-5-7, RV 5-21-4, RV 10-79-3
Saspiñjarāya	Tender grass in red and yellow colours	TS 4-5-2(3), TS 4-5-11(5)
Śuṣkyāya	Dried tree wood	TS 4-5-9(9)
Vanyāya	Forest	TS 4-5-6(9)
Vibhu	Superior grains	TS 4-7-4
Prabhu	More superior grains	TS 4-7-4

(*contd.*)

Table 1 — List of botanical and agricultural terminologies revealed in the *Vēdic* Texts (*contd*.)

***Vēdic* Sanskrit Name**	**Botanical Form**	**Vēda Reference**
Bahu	Much Superior grains	TS 4-7-4
Bhūya	Much more superior grains	TS 4-7-4
Pūrṇam	Filled grains	TS 4-7-4
Pūrṇataram	Fine-filled grains	TS 4-7-4
	Agricultural Terminology	
Bīja	Seed	RV 10-94-13, RV 10-101-3; AV 10-6-33; TS 7-5-20(1); SB 7-2-2(4)
Dhānya	Grain	RV 6-13-4; AV 3-24-2(4), AV 5-29-7, AV 6-50-1; KB 9-8; SVB 5-5
Grāmyāṇi	Grain crops of 14 types	BU 6-3-22
Kārṣīvaṇa	Plougher	AV 6-116-1
Khanitrima	Irrigation	RV 7-49-2; AV 1-6-4, AV 19-2-2
Kṛṣi	Ploughing	RV 1-23-15; AV 2-4-5, AV 8-2-19, AV 10-6-12, AV 12-2-27; TS 7-1-2(1); MS 1-2-2; MS 3-6-8; VS 4-10, VS 9-22, VS 14-19, VS 14-21; SB 7-2-2(7); SB 8-6-2(2); TB 3-1-2(15), TB 3-1-2(16), TB 3-1-5
Kṛṣṭapacyam	One time ploughed field	TS 4-7-5
Akṛṣṭapacyam	Unploughed field	TS 4-7-5
Kṣētra	Plough land	RV 1-110-5
Kṣetrapati	presiding deity of agriculture	RV 4-57-1 to 8
Lāṅgala	Plough	AV 3-17-3, AV 6-91-1; TS 4-2-5(6); KS 16-22; MS 2-7-12; VS 12-71
Sasya	Crop (corn)	TS 3-4-3(3), TS 5-1-7(3), TS 7-5-20(1); MS 4-2-2; AV 7-2-1, AV 8-10-24
Śakan or *Śakṛt*	Manure	RV 1-161-10
Sīra	Plough	RV 4-57-8, RV 10-34-13, RV 10-101-3, RV 10-101-4, RV 10-117-7; AV 6-30-1, AV 6-91-1, AV 8-9-16; TB 1-7-1(2), TB 2-5-8(12); VS 18-7; MS 2-2-4, MS 2-6-2; AV 6-91-1, AV 8-9-16; TS 5-2-5(2); KS 15-2; SB 7-2-2(6), SB 13-8-2(6); TS 1-8-7(1), TS 5-2-5(2)
Urvarā	Plough land	RV 8-91-5
	***Agriculture Seasons* (TS)**	
Vasanta	Spring	TS 1-6-2 and TS 7-2-10(2)
Grīṣma	Summer	TS 1-6-2 and TS 7-2-10(2)
Varṣa	Rainy or Monsoon	TS 1-6-2 and TS 7-2-10(2)
Śarad	Autumn	TS 1-6-2 and TS 7-2-10(2)
Hēmaṃta	Winter	TS 1-6-2 and TS 7-2-10(2)
Śiśir	Fall	TS 1-6-2 and TS 7-2-10(2)
	***Agriculture Operations* (YV)**	
Kṛṣanta	Ploughing	SB 1-6-1(3)
Vapanta	Sowing	SB 1-6-1(3)
Lunanta	Reaping	SB 1-6-1(3)
Mṛṇanta	Threshing	SB 1-6-1(3)
	***Instruments for Harvest and Post-Harvest* (RV)**	
Dātra or Sṛṇi	Sickle	RV 4-38-1
Parṣa	Bound into bundles	RV 10-48-7
Khala	Beaten out on the floor of a granary	RV 10-48-7
Taitau	Grain separation and sieving	RV 10-71-2; AV 12-3-19
Śūrpa	Winnowing fan	RV 10-71-2; AV 12-3-19; TS 1-6-8; TB 3-2-5(11)
Dhānyā kṛt	Winnower	RV 10-94-13
Ūrdara	Grain measuring vessel	RV 2-14-11

| यव॑ड्ग्रीष्मायौष॑धीर्व॒र्षा॒भ्यो" व्री॒हीड्ड्छर॑दे॑ माषति॒लौ हे॑मन्तशिशि॒रा॒भ्या॒ं तेने॒द्र॑म् ||

[| yavaṅgrīṣmāyauṣadhīrvarṣābhyō vrīhīṁścharadē māṣatilau hēmaṃtaśiśirābhyāṃ tēnēdram ||] – **TS 7-2-10(2).**

The barley crop ripened in summer, being no doubt sown, as in modern India, in winter; rice ripened in autumn, being sown in the beginning of the rains. Beans and sesamum, planted at the time of the summer rains, ripened in the winter and the cool season.

The TS [5-1-7(3)] clearly mentions that there were two harvests (***sasya***) a year. The winter crop was ripe by the month of C*haitra* (March-April) according to the KB (19-3).

| तस्मा॒द् द्वि स्स॑ंवथ्स॒रस्य॑ स॒स्यं प॑च्यते ||

[| tasmād dvi ssaṃvathsarasya sasyam pacyatē ||] – **TS 5-1-7(3)**

Agriculture lands

The RV (10-43-3) recognizes two types of land. These are fertile (***apnasvatī***) and arid (***ārtanā***). The former is marshy or riverine tract, known as ***anūpa*** and the latter, arid, is known as ***jāṅgala*** in the post-*Vēdic* period. ***Ūṣara*** (alkaline) and ***anūṣara*** (non-alkaline, i.e., cultivable land), the two divisions of land are found in the later *Vēdic* texts, *Āśvalāyana Gṛhya Sūtra* [2-7-2(3)] and *Gobhila Gṛhya Sūtra* [4-7-8].

There is clear proof of importance attached to agriculture mentioned in the RV *mantras* (10-34-13 and 10-117-7). The plough land was called ***urvarā*** or ***kṣētra***; manure (***śakan***, ***śakṛt***, ***karīṣa***, RV 1-161-10) was used, and irrigation was practiced (***khanitra***). ***Khanitrima***, 'produced by digging,' as an epithet of *āpaḥ* (waters) clearly refers to artificial water channels used for irrigation, as practiced in the times of the RV (7-49-2) and the AV (1-6-4 and 19-2-2). The plough (***lāṃgala***, ***sīra***) was drawn by oxen, teams of six, eight, or even twelve being employed (AV 6-91-1; KS 15-2; RV 8-6-48 and RV 10-101-4).

Agriculture operations

The operations of agriculture (Table 1) are neatly summed up in the SB [1-6-1(3)] as 'ploughing, sowing, reaping and threshing' (***kṛṣanta, vapanta, lunanta*** and ***mṛṇanta,*** respectively). In the RV (8-78-10, 10-101-3 and 10-131-2), the harvest and post-harvest phenomena was elucidated, the ripe grain panicles were cut with a sickle, (***dātra, sṛṇi***), bound into bundles (***parṣa***) and beaten out on the floor of the granary (***khala***) (RV 10-48-7). The grains were then separated from the straw and refuse either by a sieve (***taitau***) or a winnowing fan (***śūrpa***) (RV 10-71-2; AV 12-3-19). The winnower was called ***dhānya-kṛt*** (RV 10-94-13) and the grain was measured in a vessel called ***ūrdara*** (RV 2-14-11).

It is mentioned in the AV (6-50-142 and 7-2) that the farmer had plenty of troubles of his own, like the birds destroying the seeds of the crop, various kinds of reptiles (***upakvasa, jabhya, tarda, patanga***) injuring the young shoots of the crop plants and the crops getting damaged due to excessive rain and drought. The AV also contains spells to prevent these evils[16].

Conclusions

For centuries, the knowledge in India was passed down from generation to generation through schools called *gurukulas* (family of the guru) and transmitted entirely from mouth to ear in an unbroken oral tradition. Gradually, they came to be written down on different materials such as stones, copper plates, birch bark, palm leaves, parchments and paper. Even after the tradition of writing started, the oral teaching continued to be the means employed for learning the *Vēdas*. The treasure of the wisdom containing the ancient knowledge systems has come down to us in the form of manuscripts. Translated into different Indian languages, these manuscripts are spread all over the country in different institutions, libraries, mutts, monasteries, temples and in several private collections. In fact, India has possibly the oldest and the largest collection of manuscripts anywhere in the world. However, a vast amount of this wealth has been lost through the ages. Presently, the knowledge of *Vēdas* has spread around the globe due to the various modes of media and technologies available.

Science in general and plant science in particular is an integral part of the *Vēdas*. Although various terminologies are available now in modern botany, they, in fact, originated from the vast *Vēdic* literature. The authenticity of various botanical descriptions is in the *Vēda mantras* and in the name of standardization. The fact is that our understanding and analytical capacity is still restricted and fails to match with the very high standard of *Vēdic* literature. Although literature related to botanical descriptions and

information in *Vēdas* are available in *Ṛgvēda* (RV), *Yajurvēda* (YV) and *Atharvavēda* (AV), but they are mostly in discrete form. Attempt has been made to compile it at one place for the benefit of interested scholars and readers. In this article, the plant biological and agricultural knowledge that is revealed in the *Vēda Saṃhitās*, *Brāhmaṇās*, *Araṇyakās* and *Upaniṣads* are discussed and detailed with the *Vēda mantras*/liturgy. It is found that the plants and trees have several-fold importance in the *Vēdas*. It is clearly evident from the discussion that the morphology, taxonomy, classification of plants, anatomy, physiology, the agricultural and botanical terminologies are revealed in the *Vēdas* with a specific purpose.

An early example of ancient plant classification is found in the *Vēdas* (RV, YV and AV), through a collection of *Vēdic* hymns and liturgy. RV and YV divided plants into *vṛkṣa* (trees), *ōṣadhi* (herbs useful to humans) and *vīrūdh* (creepers). AV divides plants into eight classes. The existing plant classification systems that were formed using RV, AV and TS became scientific (botanical) with the work done by Parāśara, the author of *Vṛkṣāyurvēda* (the science of life of trees). This text was considered to be the ancient botany literature. The TS and VS classify the plant kingdom into 8-10 classes based on their form and growth. Also, the YV classified plants into herbs and trees based on the important organs of the plant body. Both leaves and roots are classified based on their structure. The anatomical features of a human being are compared with a tree by providing the information on the internal structure and organs, in the BU. The vital processes such as photosynthesis, respiration, biosynthesis and accumulation of substances of plant life are described in the RV. This indicates that the sages of those days had adequate scientific knowledge on the various botanical aspects, activities in plants, and also the knowledge of cultivating crops as per the seasons, number of crops per year and other agricultural facets. Agriculture in the *Vēdic* period was thus a religio-social activity with all its ancillary aspects from soil to weather forecasts.

Several botanical terms are described in all the four *Vēdas* and particularly in the *Yajurvēda* (YV). The *Taittirīya Saṃhitā* (TS) and the *Vājasanēyī Saṃhitā* (VS) describe and explain the various plant parts. More than 25 biological terms (including agriculture) are detailed in the *Śrī Rudram* or *Śatarudrīyam*. Likewise, many botanical and agricultural terms that can be identified with the modern botany are discussed. These terminologies that are revealed in the *Vēda Saṃhitās*, *Brāhmaṇās*, *Araṇyakās* and *Upaniṣads* are listed in the Table 1.

In fact, many aspects of modern botany can be traced back to *Vēdas* and other derived Sanskrit literature. Based on the plant classifications described in the *Vēdas*, *Manusmṛti* - the '*Dharmasāstra* of Hinduism', classified plants into eight major categories. Elaborate taxonomies also occur in the *Caraka-saṃhitā*, *Suśruta-saṃhitā* and *Vaiśeṣika*. Thus, we should comprehend that the 'ancient scientists', the *ṛṣis*, did realize the need to classify plants according to their various characteristics and properties. In most cases they come close to modern classifications.

To further conclude, there is an urgent need in protecting the traditional knowledge such as the *Vēdic* botany and agriculture for future generations. The *Vēdic* botany can be adopted as part of the syllabi at higher levels of education in order to propagate our traditional knowledge amongst the later generations.

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Conflict of Interest

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