Introduction
Agriculture has usurped about 40% of the land surface of the world (Kreft 2016), and indeed agricultural land now constitutes one of the world’s major biomes (Zabel, Putzenlechner, and Mauser 2014), albeit artificial. Tanentzap et al. (2015) commented: ‘Agriculture dominates the planet. Yet it has many environmental costs that are unsustainable, especially as global food demand rises… Agriculture’s demand for land drives conversion of natural habitats, and this is arguably its largest environmental cost… Agriculture also contributes more to other forms of environmental degradation than any other economic sector.’ The negative effects of agriculture on biodiversity are the result not just of land clearing (associated with habitat elimination; see Figure 1), but also are due to overharvesting, pollution or degradation of the soil, water and atmosphere (particularly through the use of fertilisers and pesticides) and overuse of fresh water. Da Silva Dias (2015) pointed out that the only significant way to increase arable land today requires deforestation – hardly an acceptable solution from the perspective of biodiversity conservation. As stated by Bennett (2017), ‘One of the most critical problems of our time is guaranteeing food security for all while at the same time shrinking agriculture’s overlarge environmental footprint.’ This contribution discusses an agricultural crop that is exceptionally

Figure 1. Deforestation: a rainforest burning in Brazil. Such land clearing to establish agricultural production appears to be the leading cause of habitat elimination and associated biodiversity loss. Photo (public domain) by U.S. National Aeronautics and Space Administration.
compatible with sustainable maintenance of ecosystems and their constituent biodiversity.

The plants

As detailed below, two species in the Buckwheat genus *Fagopyrum* are often cultivated. The number of species in *Fagopyrum* is uncertain (Ohnishi 2016). Tang et al. (2014) stated that there are 23, with at least ten in China. 'Wild Buckwheat' is a name used for *Eriogonum*, a North American genus with 250 species. *Eriogonum* and *Fagopyrum* are in the Knotweed family (Polygonaceae).

Common Buckwheat (*F. esculentum*, Figure 2a) is an annual herb, 0.6–1.5 m (2–5 feet) tall. The stems are hollow, and vary in colour from green to red, becoming reddish-brown at maturity. The clustered flowers are typically white, sometimes pink and occasionally yellow. The weak taproot bears numerous thin fibrous roots. The nut-like seeds or grains (fruits, botanically; Figure 3) are 5–8 mm (0.2–0.3 inch) long, brown, grey-brown, silver or black, wide at the base and triangular to almost round in cross section. In ‘Notch-seeded Buckwheat’ the angles or edges of the seed are extended into wide, rounded margins or wings. The seed is made up of a thick outer hull and an inner, edible groat ('groats' are hulled kernels of grains). Buckwheat grains approximate the shape of tetrahedrons. (A tetrahedron or triangular pyramid is a flat-sided solid with a triangular base and three sides.)

Tartary Buckwheat (*F. tataricum*, Figure 2b), another annual species, is closely related to Common Buckwheat, but is usually smaller and more slender, and its seed is about 40% smaller. It is more frost-tolerant than Common Buckwheat. This plant produces inferior, relatively bitter flour, and poorer honey, but is hardier and is sometimes considered a more productive feed for livestock. In some regions of the world, Tartary Buckwheat is used as human food, but it leaves a very bitter taste after being eaten. There are, however, some improved varieties available.
Common Buckwheat probably originated in Asia, where it may have been cultivated for as long as 6000 years, although it has also been claimed that domesticated forms are no older than about 2000 years (Campbell 1997). It has been suggested that temperate East Asia, especially including the eastern side of the Himalayas and Southwest China, represents the pre-domestication native distribution area (Gondola and Papp 2010). Ohnishi (2004) emphasised the Yunnan area of China as being particularly significant as a site of domestication of Common Buckwheat. It was spread to Europe by the 1400s. Colonists brought Common Buckwheat to the Americas after the discovery of the New World. While it was once widely cultivated as a peasant crop (Figure 4), it is commonly grown today as a conventional food crop that is planted and harvested by machinery. However, during the twentieth century, the increasing use of synthetic nitrogen-based fertilisers removed the great advantage the Buckwheat has as a grain crop – its ability to grow well on poor soils. This resulted in a considerable increase in cultivation of Wheat and other cereals at the expense of Buckwheat, which today is mainly consumed in Asia and Eastern Europe.

‘Tartary’, in Tartary Buckwheat, is an indefinite historical region in Asia and Europe, extending from the Sea of Japan to the Dnieper River north of the Black Sea. Tartary Buckwheat appears to grow wild in China and Siberia, which includes part of the geographical area of Tartary. The species also grows wild in Tibet, Kashmir and northern Pakistan, and presumably was domesticated somewhere in its primeval distribution area. Tartary Buckwheat has never achieved the popularity of Common Buckwheat, and where the name ‘Buckwheat’ is employed in this paper the reader should assume that Common Buckwheat is meant. (Where the species or plant is mentioned, the B in Buckwheat is capitalised; where the food product is referred to, it is not.)
The subtle flavour that complements foods such as breakfast cereals, fish and desserts.

The most common form of roasted buckwheat is kasha (Russian for porridge, Figure 5a), which is prepared by roasting buckwheat groats, and is used in many traditional Jewish and Polish dishes, and also by other ethnic groups. 'Blinis' are small, thick Russian pancakes prepared with buckwheat flour. The Yiddish 'blintze' was taken up from Russian to also indicate a small pancake, but one that is thin and folded around a filling such as cream cheese or mashed potato (essentially it is a crêpe). 'Pizzoccheri' (pronounced pee-tzo-kae-ree) are thick, dark, Italian pasta strips prepared from buckwheat flour. Buckwheat groats are used to decorate bread and other baked goods, as a meat substitute or extender, for stuffing meats and vegetables, for mixing in soups and stews, and as a side dish. The Brittany region of France is famous for its buckwheat crêpes. In Sweden, buckwheat is used to stuff fish. Buckwheat is sometimes used to make alcoholic drinks, ice cream, and reportedly in China to make vinegar. Young leaves and shoots of Buckwheat are eaten as a vegetable in many areas of the Indian subcontinent.

Much of the North American crop of Buckwheat grain is exported to Japan, mostly for making noodles. The desired flavour is obtained only from fresh grain, and the Japanese market accordingly does not accept old buckwheat. Old and new buckwheat are readily distinguished, as old buckwheat displays a reddish-brown colour when hulled while new buckwheat has a greenish tinge when the hulls are removed. In Japan buckwheat flour is combined

Figure 4. Peasant cultivation of Buckwheat, as shown in art. (a) 'Sowing Buckwheat'. Source (public domain): Stall, S. 1911. With the children on Sunday, through eye-gate, and ear-gate into the city of Child-Soul. Philadelphia: Vir. (b) 'Buckwheat harvest' by Jean-François Millet, painted between 1868 and 1874, housed in the Museum of Fine Arts, Boston (public domain photo).
Typically, about 12–14% of hulled buckwheat grains are protein (Izydorczyk et al. 2014). The proteins in buckwheat have been described as the best known source of high biological value protein in the plant kingdom, having over 90% of the value of dried non-fat milk solids, and over 80% of that of dried whole eggs. Buckwheat is an excellent source of the protein component (amino acid) lysine, which is often deficient in grains. Buckwheat flour has an energy value in calories about equal to that of whole wheat, Limburger cheese, or certain cuts of ham and beef. Despite all these advantages, the total nutrient value of buckwheat grain is lower than that of the leading cereals.

When cooking buckwheat, whole-grains require about 30 min, cracked grains 15–30 min. About two cups of liquid per cup of buckwheat are required, and the cereal should be added to a boiling liquid. Adding a beaten egg that has been cooked briefly and combining it with the cereal in boiling water makes buckwheat less mushy (the albumin in the egg seals the grains). Buckwheat can also be cooked together with white rice.

Whole-grain buckwheat can be stored for up to a year under cool, dry conditions. Buckwheat flour will keep for several months at room temperature, but is best with wheat flour to produce ‘soba’ (pronounced so-BAH) or buckwheat noodles (soba is Japanese for buckwheat). Soba noodles are typically thin, flat and greyish-brown (Figure 5d), and are consumed with soy sauce, either cold or hot. Chasoba (= cha soba; pronounced cha-SOH-ba and CHA-so-bah) is a unique form of soba noodle made with green tea. It is served on special occasions in Japan, generally during the tea ceremony. Yamaimo soba is flavoured with yams. The top Japanese restaurants make their own noodles using premium buckwheat that costs up to ten times as much as the buckwheat used to make the cheapest noodles. Buckwheat is extremely popular in Japan where it is sometimes referred to as the ‘Meat of the Fields’.

As discussed in previous paragraphs, buckwheat has long been employed in ethnic dishes, particularly in Asia and eastern Europe. A century or so ago, buckwheat was also a popular breakfast cereal in Western countries, as evidenced by heirloom drawings (Figure 6) and collector’s art cards (Figure 7) of past times. Today, buckwheat is slowly regaining popularity in western Europe and North America because of its growing reputation as a particularly healthy cereal.
Figure 6. A charming cartoon of a family consuming buckwheat pancakes. Source: Nesbit, W.D., and C. Briggs. 1913. Oh Skin-Nay!: The Days of Real Sport. Chicago: P.F. Volland.

Figure 7. Commercial advertising cards (public domain) for buckwheat products, created in 1890s for Heckers' Cereals.
stored in an airtight container in a refrigerator, since the high fat content promotes rancidity. Commercial buckwheat flour and pancake mixes often are stabilised with additives, which may not be beneficial for taste.

**Toxicity**

Fagopyrism or buckwheat poisoning is an irritating rash of humans and livestock induced by a combination of heavy consumption of buckwheat and exposure to sunlight. In humans, a continued heavy diet of buckwheat cakes results in development of the skin rash in certain people who are allergic to buckwheat protein. However, a small percentage of buckwheat consumers have experienced allergic reactions just from eating a small amount, and some even undergo fatal anaphylaxis (Heffler et al. 2014). Buckwheat allergy has even been triggered by inhalation of residual flour particles while using a pillow filled with buckwheat hulls (Lee et al. 2013). Animals fed a buckwheat ration may also develop a rash, but the effect is confined to white-haired and unpigmented animals that are exposed to light. The chemical responsible, fagopyrin (actually a collective term for several similar compounds), is present in larger amounts in the foliage than in grain (Stojilkovskia et al. 2013). Appreciable fagopyrin is present in sprouts, and it has been recommended that no more than 40 g of Buckwheat sprouts be consumed daily (Kreft, Jane, and Kreft 2013).

**Medicinal uses**

*Fagopyrum* species, especially Tartary Buckwheat, have been employed for centuries to treat various diseases in traditional or folk medicine in Eurasia. Currently, studies are underway to assess potential medical and nutritional applications (Ahmed et al. 2014; Christa and Soral-Śmietana 2008; Giménez-Bastida and Zieliński 2015; Jing et al. 2016; Kreft 2016; Lim 2013; Zhu 2016). Buckwheat species are sometimes employed as pharmaceutical crops, especially for extraction of the compounds described in the next two paragraphs.

Rutin, a chemical harvested from Buckwheat leaves, is used in medicine to evaluate and treat blood vessels for hemorrhagic diseases such as retinal bleeding and stroke, and also in the treatment of frostbite. Tartary Buckwheat contains much more rutin than Common Buckwheat (Chauhan et al. 2010). Rutin is abundant in buckwheat bran, and in the diet is said to reduce cholesterol, lower blood pressure, and strengthen diseased, weakened veins and arteries (Suzuki et al. 2015).

Fagopyritols, compounds derived from Buckwheat, have been used to help manage diabetes (Steadman et al. 2000). Indeed, Tartary Buckwheat noodles have been recommended in China as a treatment for diabetes.

**Miscellaneous uses**

In addition to its uses in human food, Buckwheat seed is also used as feed for livestock. Buckwheat is considered a good addition to ‘scratch feed’ mixtures for poultry (the birds ‘scratching’ the soil to retrieve seeds scattered on the ground). Sometimes chickens are released into pastures planted with a mix of grains, including Buckwheat, to feed, free-range, on seeds that they can find. Buckwheat hay is fed to livestock, although it is considered to be of lower-quality than forage cereals (Pavek 2016). As noted later, allergic reactions are possible.

Buckwheat hulls are used as filling for therapeutic pillows and mattresses. Buckwheat hull pillows are particularly popular. The interlocking shape of the hulls is said to contribute to good support as they can be moulded by hand to conform to individual neck and head alignments. Predating the modern buckwheat pillow, geishas in ancient Japan slept with their heads on bags filled with Buckwheat chaff in order to preserve their elaborate coiffures.

**Economics**

Today, about 90% of world production is based on Common Buckwheat, which is grown especially in Eurasia (Figure 8). The leading producers are China and Russia (Table 1). Buckwheat grows best in cool, moist climates. Relatively limited amounts are planted in North America. In Canada it is produced particularly in the Prairie Provinces. In the United States it is raised extensively in many of the northern states. Tartary Buckwheat is mainly cultivated in mountainous regions of Bhutan, China, Nepal and Northern India. In North America, Tartary Buckwheat has been cultivated to a limited extent in eastern Canada and mountain areas of the eastern United States.

Common Buckwheat grows relatively well on soils of poor quality, especially sandy and acidic ground, and so is often cultivated on marginal or fairly unproductive land.

| Country                  | Area (ha) | Production (tonnes) |
|--------------------------|-----------|---------------------|
| Russian Federation       | 712,047   | 661,764             |
| China (People’s Republic)| 708,000   | 564,900             |
| Ukraine                  | 136,700   | 167,440             |
| Poland                   | 62,710    | 83,499              |
| USA                      | 78,000    | 83,000              |
| France                   | 30,100    | 111,300             |
| Brazil                   | 49,000    | 64,000              |
| Kazakhstan               | 64,481    | 46,530              |
| Lithuania                | 37,400    | 35,600              |
| Japan                    | 59,990    | 31,100              |

Table 1. Top ten Buckwheat-producing countries in 2014. Data from FAOSTAT (http://www.fao.org/faostat/en/#data/QC).
1. Cover crop

‘Cover crops’ are variously defined, but the concept usually refers to herbaceous vegetation temporarily planted (as short as part of a season or as long as several years) to rehabilitate, maintain or improve the soil for the purpose of subsequently growing plants that are more valued for harvest of economic products. Cover crops (said to cover the soil) are particularly valued for preventing soil erosion when land is left fallow for some time. Also, rain can leach some minerals out of the soil, but cover crops tend to absorb these, keeping these nutrients available for future plants. Cover crops can also maintain soil quality, conserve water, and prevent weeds, pests and diseases. In addition to conserving soil biodiversity, by providing food and living quarters, cover crops are capable of increasing biodiversity.

Biodiversity values

As reviewed in the following, Buckwheat is extraordinarily versatile, serving a wide variety of agricultural roles while also contributing to the welfare of biodiversity. The following 15 categories employed here to describe agro-ecological functions of crops are in most cases not mutually exclusive, but serve to emphasise that what is very good for agriculture can also be very good for biodiversity.

Figure 8. Cultivated fields of Buckwheat (*Fagopyrum esculentum*). (a) Crop in Nepal. Photo by Saroj Kumar Dhakal (CC BY SA 3.0). (b) Crop in Japan. Photo by Tanaka Juuyoh (CC BY 2.0).

Tartary Buckwheat is fairly frost-tolerant, and so is cultivated especially in the Himalayan regions of Bhutan, India and Nepal, especially in high altitude areas over 2000 m (6600 ft).

Figure 9. A Buckwheat cover crop between grapevines in an organic vineyard in New Zealand. Photo Courtesy of the proprietors, Jason and Anna Flowerday, Te Whare Ra Wines (Marlborough, NZ).
on-farm local wildlife, including migrating birds. The use of cover crops is a critical technique of ecologically-friendly agriculture, and has been heavily promoted. Several of the functional crop categories described in the following may be considered as subcategories of cover crops. Buckwheat is very widely employed as a cover crop (Figure 9; Björkman and Shail 2013; Boglaienko et al. 2014).

2. Green manure crop
A ‘green manure’ or ‘plough-down’ crop is one that is turned under to improve the soil (note Figure 10). Buckwheat grows well and relatively quickly on poor soil, so it is often used for soil renovation. It can often produce 4.5–6.7 t/ha (2–3 tons/acre) of dry matter in just 6 to 8 weeks. Moreover, Buckwheat residues decompose quickly, making nutrients available for subsequent crops. Over-farmed lands with considerable decaying organic matter can be rehabilitated by planting Buckwheat, which grows well in such soils. Buckwheat itself is adapted to soils of low fertility, and the residual nutrients provided to other crops grown recently usually means that substantial fertilisation is unnecessary.

3. Nutrient scavenger crop
‘Scavenge’ has various meanings, one of which is to salvage, and this is the sense meant when referring to scavenging plants. Most crops that are termed scavengers have deep roots that take up nutrients from considerable depth in the soil, and often compensate for soil deficiencies near the soil surface caused by shallow-rooted crops. Although Buckwheat does not have deep roots, it is a particularly efficient absorber of phosphorus and calcium from the soil, which are released to other plants when the plant decomposes (Arcand et al. 2010; Das, Avasthe, and Singh 2015).

4. Smother crop
A ‘smother crop’ or ‘weed suppressor’ is one that grows so quickly it shades out (or ‘smothers’) weeds. Buckwheat is sometimes used as a smother crop because it germinates and grows rapidly to shade out weeds. Buckwheat germinates in just 3 to 5 days, and within 2 weeks can produce a dense canopy.

Shading is believed to be the chief mechanism of weed suppression by Buckwheat, but there is also a form of ‘chemical warfare’. Plants sometimes compete against other plants by ‘allelopathy’ – the release of chemicals into the soil that inhibit the growth of other plants. Buckwheat has been shown to be significantly allelopathic against competing weeds (Falquet et al. 2015; Iqbal et al. 2002; Wirth and Gfeller 2016) A compound called diethyl phthalate produced by Buckwheat appears to be responsible for suppression of some other plants. Buckwheat also can suppress some root pathogens.

5. Nurse crop
A ‘nurse-crop’ is one employed to aid another crop in getting established. Often rapidly-growing short-lived plants such as Buckwheat are used to assist slower-growing but longer-lived crops to get established. The nurse crop provides some of the same benefits described previously for cover crops, green manure crops and smother crops. Buckwheat is too fast-growing to be employed as a nurse crop in most circumstances, but has been used to protect late-autumn planting of winter-hardy legumes (e.g. Alfalfa), since frost kills the Buckwheat before it outgrows the legumes.

6. Companion crop
‘Companion crops’ are planted very closely to each other because at least one of the partners can aid the other in some respect. Both crops need not benefit equally; for example, a ‘trap crop’ is one that is grown simply to
lure away herbivores from a more valuable nearby crop (Holden et al. 2012; Parker et al. 2013). Nurse crops discussed previously could be considered to be a subcategory of companion crops, but the latter tend to accompany each other through the entire season or life cycle. Perhaps the most publicised example of companion planting is the ‘Three Sisters’ practice of indigenous American people of growing Corn to serve as a trellis for vine forms of Beans to climb upon, while taking advantage of the latter to add nitrogen to the soil, and Squash between the corn plants to act as a cover crop. Companion crops represent an antidote to monocrops, the uniformity of which is detrimental to biodiversity. Companion crops tend to make environments heterogeneous, supplying niches that can be occupied by various organisms. Companion crops also tend to discourage outbreaks of particular insects and diseases, and so lessen the need for biocides that are detrimental to biodiversity.

‘Mesclun’ refers to a mix of salad greens, such as lettuce, spinach and mustard. These plants need to be grown separately, but some forages for livestock can be grown together, and therefore receive the advantages of companion crops described above. Buckwheat grows well in mixtures with some cereals and pasture grasses intended either as living feed for foraging livestock or for hay or silage, and mixtures with Buckwheat can also be employed as cover crops and honey crops.

7. Rotation crop

Crop rotation is the sequential growth of a series of different types of crops in the same location, usually in succeeding seasons. A chief benefit of crop rotation is that diseases and pests built up on one crop are substantially eliminated when a different crop is grown in the same soil. The new crop planted after the crop that has accumulated diseases and pests is often called a ‘break crop.

Another important benefit is that some crops add nutrients to the soil, compensating for the removal of the same elements by the preceding or succeeding crop. Crop rotations tend to increase yields and may be beneficial to biodiversity, especially soil organisms. Most high-value crops are grown on rich soils, which are not ideal for Buckwheat, so it is not usually included in year-to-year rotations. When Buckwheat is grown as a cover crop, green manure crop, or nurse crop, it is effectively being employed as a rotation crop, albeit frequently the crops alternate within a single season.

8. Emergency crop

When cash crops (those grown for sale) fail, rapidly growing and maturing crops can sometimes be planted as a secondary income crop to salvage part of a farmer’s season. Such crops grown as a substitute for a failed crop are sometimes called ‘catch crops’ (the phrase is also used to designated fast-growing crops cultivated between successive plantings of a slow-growing main crop; and is also employed in a quite different sense to refer to cover crops intended to retain (‘catch’) nutrient elements, especially nitrogen (Thorup-Kristensen, Magid, and Stoumann Jensen 2003). Still another phrase that is sometimes used is ‘rescue crop’. Buckwheat can often be employed when a crop fails, providing income to the farmer but also giving him the opportunity of growing a genuinely biodiversity-friendly plant. An ‘emergency cover crop’ is one that is employed when a main crop fails and it is important to prevent weeds from taking over the area.

9. Soil texture conditioner crop

‘Tilth’, referring to the degree of aggregation of soil particles, is critical to both the ability of crops and soil biodiversity to thrive in soil. Improving soil tilth is one of the several important factors that contribute to soil health that have been championed by soil science (note Figure 11). Compacted soil, with soil particles crushed together, makes it difficult for roots to grow and prevents many soil species from finding habitats. As well, air penetration to the soil becomes more restricted for all living things, and (depending on the size of soil particles) there may be too little or too much water. Conversely, friable (loose, easily penetrated) soil promotes root growth, appropriate water retention, and aeration. Buckwheat produces abundant fine fibrous roots in the top 25 cm (10 inches) of soil, and these loosen and aerate the ground, making it more suitable not only for subsequent crops but also for soil biota.

10. Pollinator crop

Buckwheat fields are often employed by beekeepers to produce a high quality honey sold at premium prices. Buckwheat honey is generated mainly in Europe, Canada, California and China (Pasini et al. 2013). The flowers are abundant, starting as early as 3 weeks after planting, and the flowering period can last 2 months. Buckwheat produces a dark, strong-flavoured, honey that is disliked by some, highly admired by others. One hectare (2.47 acres) of buckwheat may produce up to 160 kg (370 lb) of honey per growing season. While cultured hives of honey bees are frequently employed to manufacture honey, honey crops provide very large supplies of nectar and/or pollen to wild bees in a region (note Figure 12), therefore contributing to bee biodiversity.

An additional use of Buckwheat is to attract wild pollinators to other nearby crops that need to be pollinated.
suitable for organic farming. There is abundant evidence that ‘biodiversity on organic farms tends to be greater’ (Chamberlain et al. 2010).

12. Natural pest controller crop

Buckwheat flowers attract some beneficial insects, i.e. those which attack or parasitize pest insects such as aphids and mites (Irvin et al. 2014). Such beneficial insect may include predator wasps (several families), hover flies (Syrphidae), insidious flower bugs and minute pirate bugs (both in the Anthocoridae) and lady beetles (Coccinellidae). Buckwheat is frequently planted between orchard trees or shrubs as a cover crop, but it also serves to attract beneficial insects that control orchard pests (Mizutani, Sugaya, and Yamauchi 2010; Stephens et al. 1998). Buckwheat itself is relatively resistant to pests and diseases. This natural resistance is advantageous from a biodiversity viewpoint, reducing the need and temptation to apply biocides.
forms of agriculture, albeit limited in productivity, are admirably suited to sustaining biodiversity. Buckwheat is cultivated throughout much of Asia as a subsistence crop, especially on mountainous, marginal, and fairly unproductive lands. Such ecological areas are frequently refuges for biodiversity, so it might appear that Buckwheat’s ability to be grown outside of prime agricultural lands is bad for biodiversity. The saving grace is that subsistence crops frequently occupy only small areas of a landscape, allowing considerable nearby habitats to exist. Moreover, subsistence agriculture is by its nature far friendlier to biodiversity than factory farming, the dominant form of agriculture in the Western world. Subsistence agriculture is minimal agriculture, conducted for survival rather than for profit, and does not employ the massive inputs of chemicals and machinery and expansive monocultures that are detrimental to biodiversity. Subsistence agriculture characteristically employs livestock manure and sound sustainable practices that often actually benefit biodiversity.

15. Wildlife crop

Buckwheat is occasionally planted to provide feed and wildlife habitat (or ‘cover’, not to be confused with ‘cover crop’ discussed previously). As noted earlier, it is a superb plant for bee pasturage, and it is also useful in ‘insectary gardens’. Deer and Wild Turkey are very fond of young plants, and can be pests of cultivated plots. Conversely, hunters sometimes plant Buckwheat in ‘shooters’ plots’ (euphemistically, ‘wildlife food plots’) to attract deer and

Figure 13. Drawing of Passenger Pigeons being shot in northern Louisiana. Source (public domain): Smith Bennett (illustrator). 1875. Illustrated Sporting and Dramatic News, July 3.
Turkey (Pavek 2016; University of Tennessee undated). Buckwheat grain is found in some birdseed mixes intended for wild birds. Pheasant, grouse, waterfowl and other birds are attracted by the grain, and conservation-oriented hunters are aware of the value of Buckwheat for sustain-
ment of habitat supporting game birds. Unfortunately in the past hunting was often incompatible with biodiversity, and one of the best known casualties was the Passenger Pigeon, which went extinct a century ago despite once being the most abundant bird in North America. It was a heavy feeder on cultivated grains, particularly Buckwheat, which was much more popular in the past as a crop in the United States. Farmers slaughtered the birds, both for meat and to protect crops (Figure 13).

Summary of biodiversity benefits

As detailed above, Buckwheat has a wide range of proper-
ties that improve habitats and associated biodiversity. The effects on soil are extensive: improving texture and porosity so the earth is less compacted, better aerated and holds more water; boosting content of humus and nutrient elements so plants grow better; preventing erosion; and retarding release of polluting gases to the atmosphere. These varied improvements to soil are critical to the welfare of soil species. Growing Buckwheat can contribute to the reduction of ‘agricultural inputs’, particularly biocides (herbicides, pesticides, fungicides, bactericides), synthetic fertilisers and fossil energy utili-
sation for machinery and soil preparation. By reducing these needs, the world’s habitats benefit. Still another advantage is the reduced demand for irrigation, particularly significant as the planet is running out of fresh water, and aquatic habitats are being compromised to rob nature of this resource. As noted previously, much of the world’s Buckwheat is grown by subsistence farmers, in small plots that are quite compatible with nearby habitats, unlike massive monocrops generated by factory farming. Happily, wildlife managers have learned that Buckwheat is an excellent forage for maintaining sustainable hunting, conservationists have found that Buckwheat flowers are wonderful for promoting bee biodiversity, and Buckwheat fields have been shown to promote the welfare of birds and mammals.

Why aren’t Buckwheat and other environmentally-friendly crops employed more extensively?

A large number of sustainable agricultural benefits from growing Buckwheat are described here, but Buckwheat is not necessarily useful in all field situations. For example, Irvin, Bistline-East, and Hoddle (2016) found that in southern California the use of Buckwheat as a cover crop between rows of grapevines, although helpful in some respects, did not produce a better grape crop.

Probably no crop is completely benign to biodiversity, and this is true for Buckwheat. Its adaptation to margin-
ally fertile soils has a drawback. Habitats with poor soils are often refuges for uncommon and rare species, and their limited suitability for the major crops provides some protection from being exploited for agriculture. However, Buckwheat outperforms cereal grains on soils with high levels of decaying organic matter, such as result when wooded areas are cleared, leaving a layer of plant mate-
rial. Buckwheat can also thrive on drained marshlands. Unfortunately, it is an excellent first crop to grown on such cleared lands, and so occasionally Buckwheat can contribute to the continuing displacement of wild species. Buckwheat is also a minor weed in some areas, and may even harbour pests, such as root lesion nematodes, lygus bugs and tarnished plant bugs, and so may indirectly harm ecosystems that require conservation.

All crops are grown principally for economic, not ecological reasons. Compared to the true cereal crops, Buckwheat produces less grain in good agricultural soils and climates (albeit the grain sells for more), and so as a harvested grain crop it is competitive mainly in relatively poor soils and in short-season cool climates. Although Buckwheat is a respected crop, its main economic prod-
uct is grain, and in this respect it is not competitive with the major cereals in most circumstances. However, the comparison is not fair, as the yield of the major cereals has been phenomenally increased by modern breeding techniques during the last century, whereas breeding of Buckwheat has been comparatively limited. Another factor is acquired taste: Buckwheat is remarkable in the number of ethnic groups that have adopted it as a culinary staple, but it does have a unique aroma that requires some habit-
uation, and because of the predominance of the cereals, most people are unfamiliar with its charms. Fortunately, the general public is becoming increasingly aware of the value of supporting agricultural products that are sustain-
ably produced and so make the world more habitable not just for people but for all species. Given the astonishing set of biodiversity-friendly virtues documented here for Buckwheat, it clearly deserves expanded production.

Believe it or not

- Buckwheat has two kinds of flowers: some with short styles (the part of the female structure between the stigma, which receives the pollen, and the ovary, where the ovules are fertilised and develop into seeds) and others with long styles. This
phenomenon is called heterostyly, and is uncommon. Charles Darwin (1809–1882), the Father of Biological Evolution, showed that fertilisation between dissimilar flowers (one with a long style, the other with a short style) is much more likely to result in seeds being produced than when pollen exchange is between flowers with styles of similar length.

- The Buckwheat dish kasha is so familiar to many that it gave rise to the colour term kasha, used in fashion dress design to indicate a particular shade of beige.
- In Japan, goldsmiths have long used buckwheat dough to collect the gold dust in their shops. As a result, the grain is considered to be a potent charm for collecting riches. In Japan, buckwheat noodles are traditionally eaten on New Year’s Eve in order to acquire luck to become rich in the coming year.
- How popular is your given name? Estimations of the popularity of names in the United States can be found at http://www.mynamestats.com/. There is only one person named ‘Buckwheat’ for every 10,000,000 Americans.

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Disclosure statement

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