# Federation of International Hemp Organizations



FIHO Position Paper

## Hemp in Livestock Feed

Global Summary

CONSENSUS DOCUMENT ON FEED COMPOSITIONAL CONSIDERATIONS FOR HEMPSEED BYPRODUCTS:
KEY NUTRIENTS, ANTI-NUTRIENTS AND RECOMMENDATIONS

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## Executive Summary

Industrial hemp is grown in over 75 countries and the seed or kernel of this broadacre outdoor agricultural crop has a high nutritive value for humans and livestock. Hemp seed is an excellent source of protein, fibre, amino acids, minerals and healthy fats. Food processing of hemp seed is growing due to the need to supply nutrients for human food and food ingredients.

Within normal management stored seed can undergo quality downgrades, resulting in seed not fit for food purposes. Alternative feeding to livestock can provide a sustainable re-purposing option for food processors and farmers to avoid food wastage. A secondary livestock feed market can boost processor and farmer economic positions, serving to underpin the industrial hemp seed value chain. In addition a feed market option can reduce risk for the farmer.

This review is limited to hemp seed and seed byproducts intended for use as a nutritional component of livestock feed. These are livestock species[1] such as beef or dairy cattle, poultry (broilers, layers, turkey, quail), hogs, sheep and other ruminants, or farmed fish intended to supply products for food consumption by humans. In addition to protein, seed byproducts can supply dietary fibre and healthy omega 3/6 fatty acids, and seed oil can reduce the environmental footprint of livestock production.

This review includes feed sources fed to livestock and resulting in meat, milk, eggs or organ meats sourced by humans as food products.

A unique characteristic of the industrial hemp plant is the production of plant-based cannabinoids in the flowering top and not the seed. These plant phyto-chemicals have potential for human and animal health products if further concentrated, but *not* at the levels present in seed or its byproducts. Due to incidental contact during harvest, natural residual levels are present on the outer seed shell at less-than trace amounts only. Hemp seed does not produce cannabinoids.

The only naturally-occurring cannabinoid with the potential for intoxication when concentrated is delta-9 THC tetrahydrocannabinol. However most of the residual levels on the outside of hemp seed are in the acidic precursor THC-A form. This acid form must be heated at high temperatures for a specific time period to be converted to the biologically available delta-9 THC. This heating does not occur in feed processing or within animals' digestive systems.

Due to recent discoveries in human health properties for cannabidiol (CBD) from hemp, nutritive safety in potential animal feed has also been reviewed. The cannabinoids THC and CBD present are not readily available for absorption into animal tissue through feed. It is estimated that THC or CBD present at less-than trace levels, are in turn absorbed at a 9-12% rate by livestock species.

Global research indicates that THC and CBD levels naturally present at less-than trace or residual level in hemp seed byproducts, are further reduced when fed at 1-30% portion of a feed ration. The cannabinoids THC and CBD are not transferred to food products at any level of safety significance to humans or livestock.

### Industrial Hemp – Global Production

Hemp has been cultivated globally for over 5,000 years as a source of food and fibre with references dating back to ancient China and Mesopotamia. The hemp plant is differentiated from high-THC (delta-9 tetrahydrocannabinol) drug cannabis plants and has different value chains and markets in most regions. Hemp or industrial hemp is grown as an agricultural crop by farmers and has historically evolved differently from high-THC drug cannabis.

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[1] Hempseed byproducts may also be nutritional supplements for companion animals such as horses, dogs or cats however these non-livestock species are not included in the scope of this summary.

Regulatory authorities define industrial hemp based on a maximum threshold for THC in the flowering tops, which determines if the plant variety is hemp or not. Multi-generational crop production methods maintain THC levels at or below those thresholds. These threshold definitions vary globally from 0.2% to 1% THC in the flowering tops of the hemp plant.

There are no concentrated or synthetic cannabinoids in hemp seed or its byproducts. Industrial hemp has been bred for centuries to contain extremely trace levels of THC, and regularly monitored by plant breeders globally to meet that standard.

The level of cannabinoids is very low in the non-flowering components, such that THC is essentially non-recoverable in the rest of the hemp plant. It occurs incidentally at less-than trace levels on the outer seed shell and upper primary leaf. Cannabinoids such as THC can be found at trace levels due to incidental contact with the flowering top during harvesting of the crop. When hemp seed is harvested the straw is separated from the seed, which includes some upper leaf/flower material when processed mechanically by harvesting equipment. Due to this incidental contact, THC may then get transferred during seed processing to protein products due to sifting of the dehulled material during food processing.

**Figure 1:**

**Total THC** is defined as:

delta-9 THC plus (THC-A x 0.877)

Note the THC-A acidic form is precursor and generally not available to mammals unless heated at very high temperatures for a significant time period.

Those temperatures are not reached in feed manufacturing or on-farm where livestock are fed.

The processing of whole hemp seed from broadacre outdoor production results in ready-to-eat product, food ingredients, and inputs to further food processing. This includes whole hempseed, dehulled (hulled) hempseed, fibrous seed hulls (outer shell), hemp seed oil, toasted hempseed, protein concentrates and protein isolates. In addition within a food processing plant as the seed is processed, leftover seed fines can be utilized as a feed ingredient.

For hemp seed intended for human consumption, across the world the only cannabinoid threshold determined by health authorities is total THC. In the hemp plant THC, while at minuscule levels in hemp's flowering tops, is *not* produced in seed. Thresholds were set as a precaution, as it is the only naturally occurring cannabinoid identified as intoxicating and habit-forming for humans (United Nations ECDD 2017 to 2019) when concentrated or isolated in non-food processing.

Different levels of maximum THC defined by regulation for the definition of the hemp plant around the world, result in different maximum allowable levels of THC in food derived from hemp seed. These remain at less-than trace levels.

Hemp products such as whole seed, dehulled seed, hemp seed oil, hempseed meal, hempseed hulls, and to some extent hempseed screenings have been evaluated in the production of various animals including poultry, swine, ruminants, and finfish. Studies indicate hempseed products do not negatively influence animal health indicators or animal performance. Moreover, they enhanced animal products (egg, meat, and milk) with health-benefiting bioactive components such as omega-3 fatty acids, fat, gamma-linolenic acid, and conjugated linoleic acid. Although most supporting evidence from literature on the safety and efficacy may have focused on the application of whole hemp seed, hemp seed oil, and hempseed meal for use in animal feeds, other hemp seed-derived fractions such as such as dehulled seed, and protein concentrates are nutritionally valuable for animals.

Hempseed byproducts are excellent sources of protein and energy (Mohamed et al. 2024). Data indicates the seed contains 20–25% protein, 20–30% carbohydrates (mostly as fibre), and 25–35% oil (House et al. 2010), and is valuable for livestock and poultry (Callaway 2004; Mustafa et al.1999; Silversides and LefranÇois 2005).

Hemp seed and hempseed meal are also rich in amino acids, particularly high in arginine, glutamic, and aspartic acids. In addition, hemp seed oil contains a high content of polyunsaturated fatty acid (approximately 80%) with a favourable ratio of approximately 3 to 1 of linoleic acid to alpha-linolenic acid.

**Table 1:**
**Proximate Components in Hempseed-Derived Fractions (%, As-Is Basis)[a]**

| Parameters | Seed oil [b] | Whole seed | Hempseed hulls | Dehulled seed | Hempseed Meal | Protein concentrate | Coarse seed protein | Screenings | p-value |
|---|---|---|---|---|---|---|---|---|---|
| Dry matter | 99.9 ± 0.08 | 92.8 ± 0.39$^{b}$ | 92.1 ± 0.42$^{b}$ | 94.4 ± 0.25$^{a}$ | 91.8 ± 0.34$^{b}$ | 92.8 ± 0.25$^{b}$ | 92.6 ± 0.52$^{b}$ | 92.1 ± 0.50$^{b}$ | <.0001 |
| Moisture | 0.13 ± 0.08 | 7.24 ± 0.39$^{a}$ | 7.89 ± 0.42$^{a}$ | 5.61 ± 0.25$^{b}$ | 8.21 ± 0.34$^{a}$ | 7.24 ± 0.25$^{a}$ | 7.36 ± 0.52$^{a}$ | 7.91 ± 0.50$^{a}$ | <.0001 |
| Crude protein | 0.00 | 23.9 ± 1.54$^{bc}$ | 15.7 ± 2.83$^{c}$ | 32.8 ± 0.74$^{b}$ | 33.0 ± 1.83$^{b}$ | 49.7 ± 4.15$^{a}$ | 21.5 ± 12.3$^{bc}$ | 26.6 ± 1.31$^{bc}$ | <.0001 |
| Fat | 99.8 ± 0.08 | 32.0 ± 1.07$^{b}$ | 12.6 ± 3.50$^{c}$ | 50.7 ± 0.95$^{a}$ | 8.37 ± 1.17$^{c}$ | 8.97 ± 1.60$^{c}$ | 7.60 ± 2.03$^{c}$ | 27.2 ± 2.19$^{b}$ | <.0001 |
| Fat (GC/FID) | 97.2 ± 1.04 | 32.7 ± 1.08$^{b}$ | 13.4 ± 4.14$^{d}$ | 49.6 ± 1.15$^{a}$ | 8.21 ± 1.08$^{d}$ | 8.87 ± 1.62$^{d}$ | 7.64 ± 1.87$^{d}$ | 25.9 ± 3.18$^{c}$ | <.0001 |
| crude fiber | 0.00 | 22.2 ± 0.40$^{cd}$ | 42.5 ± 2.77$^{a}$ | 3.37 ± 1.81$^{ef}$ | 26.6 ± 2.41$^{bc}$ | 10.2 ± 2.33$^{def}$ | 38.5 ± 14.3$^{ab}$ | 16.4 ± 2.87$^{cde}$ | <.0001 |
| NDF | 0.00 | 29.4 ± 0.85$^{b}$ | 58.8 ± 4.85$^{a}$ | 2.99 ± 1.45$^{c}$ | 39.3 ± 4.42$^{ab}$ | 17.0 ± 3.35$^{bc}$ | 54.7 ± 19.8$^{a}$ | 24.9 ± 5.45$^{bc}$ | <.0001 |
| ADF | 0.00 | 24.7 ± 0.61$^{b}$ | 50.2 ± 4.56$^{a}$ | 2.91 ± 1.98$^{c}$ | 32.4 ± 4.35$^{ab}$ | 13.3 ± 3.42$^{bc}$ | 45.3 ± 16.8$^{a}$ | 20.9 ± 5.15$^{bc}$ | <.0001 |
| Ash | 0.05 | 4.07 ± 0.69$^{c}$ | 3.73 ± 0.22$^{c}$ | 6.03 ± 0.79$^{abc}$ | 6.73 ± 0.39$^{ab}$ | 8.29 ± 0.82$^{a}$ | 4.81 ± 2.04$^{bc}$ | 6.08 ± 0.14$^{abc}$ | <.001 |
| NFC | 0.00 | 10.6 ± 0.39$^{b}$ | 17.6 ± 3.16$^{a}$ | 1.55 ± 0.88$^{c}$ | 17.1 ± 0.62$^{a}$ | 15.6 ± 1.18$^{a}$ | 20.2 ± 2.68$^{a}$ | 15.9 ± 0.10$^{a}$ | <.0001 |

a. Data represent means ± standard deviation (SD). Different superscripts between hemp-derived fractions in a row are significantly different at P < 0.05. n = 3 sampling sites. Abbreviations: HS = hempseed, HC/HM = hempseed cake/meal, NDF = neutral detergent fiber, ADF = acid detergent fiber, NFC = nonfiber carbohydrate. bNot included in the statistical analysis.

Source: N.Mohamed et al, Chemical Characterization of Hemp (Cannabis sativa L.)-Derived Products and Potential for Animal Feed, Canada; ACS Food Sci. Technol. 2024, 4, 88-103

**Table 2:**
**Cannabinoid Content in Hempseed Byproducts 2019a**

| cannabinoids[b] (µg/g) | HS oil (HO) | HS | HS hulls (HH) | dehulled HS | extruded HC/ HM | HS protein concentrate | High Fibre HS protein | screenings | p-value |
|---|---|---|---|---|---|---|---|---|---|
| CBD | 5.55 ± 0.64$^{ab}$ | 1.85$^{b}$ | 1.85$^{b}$ | 1.85$^{b}$ | 1.85$^{b}$ | 1.85$^{b}$ | 1.85$^{b}$ | 297 ± 153$^{a}$ | 0.003 |
| CBDA | 20.2 ± 8.11$^{b}$ | 33.6 ± 4.76$^{b}$ | 36.1 ± 8.56$^{b}$ | 19.9 ± 5.22$^{b}$ | 19.1 ± 6.32$^{b}$ | 21.5 ± 8.53$^{b}$ | 14.8 ± 10.7$^{b}$ | 475 ± 116$^{a}$ | 0.021 |
| CBD concentration | 22.0 ± 9.54$^{b}$ | 31.0 ± 5.00$^{b}$ | 34.0 ± 7.00$^{b}$ | 17.7 ± 4.73$^{b}$ | 17.3 ± 6.03$^{b}$ | 19.0 ± 7.81$^{b}$ | 13.7 ± 9.24$^{b}$ | 714 ± 236$^{a}$ | 0.019 |
| Δ9-THC | 2.65$^{b}$ | 2.65$^{b}$ | 2.65$^{b}$ | 2.65$^{b}$ | 2.65$^{b}$ | 2.65$^{b}$ | 2.65$^{b}$ | 56.1 ± 21.5$^{a}$ | 0.002 |
| THCA-A | 1.60$^{b}$ | 1.60$^{b}$ | 1.60$^{b}$ | 1.60$^{b}$ | 1.60$^{b}$ | 1.60$^{b}$ | 1.60$^{b}$ | 30.7 ± 3.78$^{a}$ | 0.002 |
| total potential THC | 5.00$^{b}$ | 5.00$^{b}$ | 5.00$^{b}$ | 5.00$^{b}$ | 5.00$^{b}$ | 5.00$^{b}$ | 5.00$^{b}$ | 83.0 ± 25.0$^{a}$ | 0.002 |

a. Data represents means ± standard deviation (SD), n = 3 sampling sites. Based on the Kruskal–Wallis test, P < 0.05 was assumed as statistically significant. Abbreviations: HS = hempseed, HC/HM = hempseed cake/meal, CBD = cannabidiol, CBDA = cannabidiolic acid, Δ9-THC = Δ9- tetrahydrocannabinol, and THCA-A = tetrahydrocannabinolic acid-A.
b. Detection limits (µg/g) for CBD, CBDA, CBD concentration, Δ9-THC, THCA-A, and total potential THC are 3.7, 2.4, 6.0, 5.3, 3.2, and 10.0, respectively

All hemp seed-derived products, except the screenings, contain levels of CBD, THC, and THC-A below the detection limits of 3.7, 5.3, and 3.2 µg/g respectively(Neijat 2024). In addition the total potential THC was below the detection limit of <10 µg/g or 10 ppm in all products except screenings. The content of the main active component (THC) in all hemp-derived products, except screenings, was below the guidelines in the range of 10-20 mg/kg (10-20 ppm) in the European Food Safety Authority (EFSA 2015) Regulation.

Typically variability occurs in screenings from all grain crops due to local growing and harvest conditions, unwanted immature seed and the amount of weed seeds present in each lot. Seed cleaning results in the mixing of whole hemp seed, distributing the cannabinoids across the outer shells of the lot. However this product is not fed in the raw form due to inconsistency in nutrition and the desire to avoid inadvertent re-seeding of weeds. Variability is managed by feed manufacturers with inclusion limits and by mixing with other feed inputs, then pelleting for uniformity and a targeted percent protein.

The very low rates of THC and CBD in hempseed byproducts feed ingredients results in a very low probability for toxicity in livestock. And in turn almost no levels of residual effects in humans eating food products of livestock origin. This is due to the existence of THC and CBD at less-than trace levels in the ingredient and the majority in the non-bioavailable form, then a dilution effect when fed at only a component of the ration (1 to 30%) for a specific phase of production

(ie. 60 to 100 days). In addition the transference rate to animal tissue is low, estimated at 9 to 12 % (up to 15%), and as evidenced by excretion in manure and urine.

At the inclusion rates of up to 2-30% in a feed ration, the potential consumption of THC or CBD by humans in food from animals fed hempseed byproducts is very small given probable daily consumption. Hempseed byproducts can be safely fed to livestock, or farmed animals intended for food production.

**Table 3:**
**Recommended Feed Inclusion Rates for Livestock Species for Hempseed Byproducts**

| Species | Whole seed | Hempseed meal | Hemp seed oil | hulls | screenings |
|---|---|---|---|---|---|
| Broiler chickens | dehulled - up to 18% | up to 15% and young birds up to 10% | up to 9% | -- | -- |
| Laying hens -including quail | dehulled – up to 9% | up to 30% | up to 4% | -- | -- |
| Grower hog | -- | up to 30% | up to 3% | up to 15% | -- |
| Gestating and Lactating sows | up to 5% | -- | up to 5% | -- | -- |
| Farmed finfish | -- | up to 20% | -- | -- | -- |
| Feeder cattle (beef) | up to 14% | Up to 20% | -- | Up to 20% | Up to 20% |
| Dry dairy cows | -- | Up to 10% | -- | Up to 20% | Up to 20% |
| Lactating dairy cattle | -- | Up to 15% | -- | Up to 15% | -- |
| sheep | Up to 5% | Up to 20% | -- | Up to 20% | -- |
| goats | -- | Up to 30 % | Up to 4% | Up to 20% | -- |

The above feed inclusion rates are based on global research 1999 to 2024.
Recommendations to be added in the future as data becomes available for products noted as "- -".

**Table: 4**
**Recommended Upper Threshold of THC and CBD in Livestock Feed Products**

| | Dehulled Hempseed | | Hempseed Meal | |
|---|---|---|---|---|
| | *Total THC* | *Total CBD* | *Total THC* | *Total CBD* |
| Global recommended level | Not more than 20 µg/gram or 20 ppm | No level recommended due to less-than trace levels - not food or feed safety issue. | Not more than 30 µg/gram or 30 ppm | No level recommended due to less-than trace levels - not food or feed safety issue. |

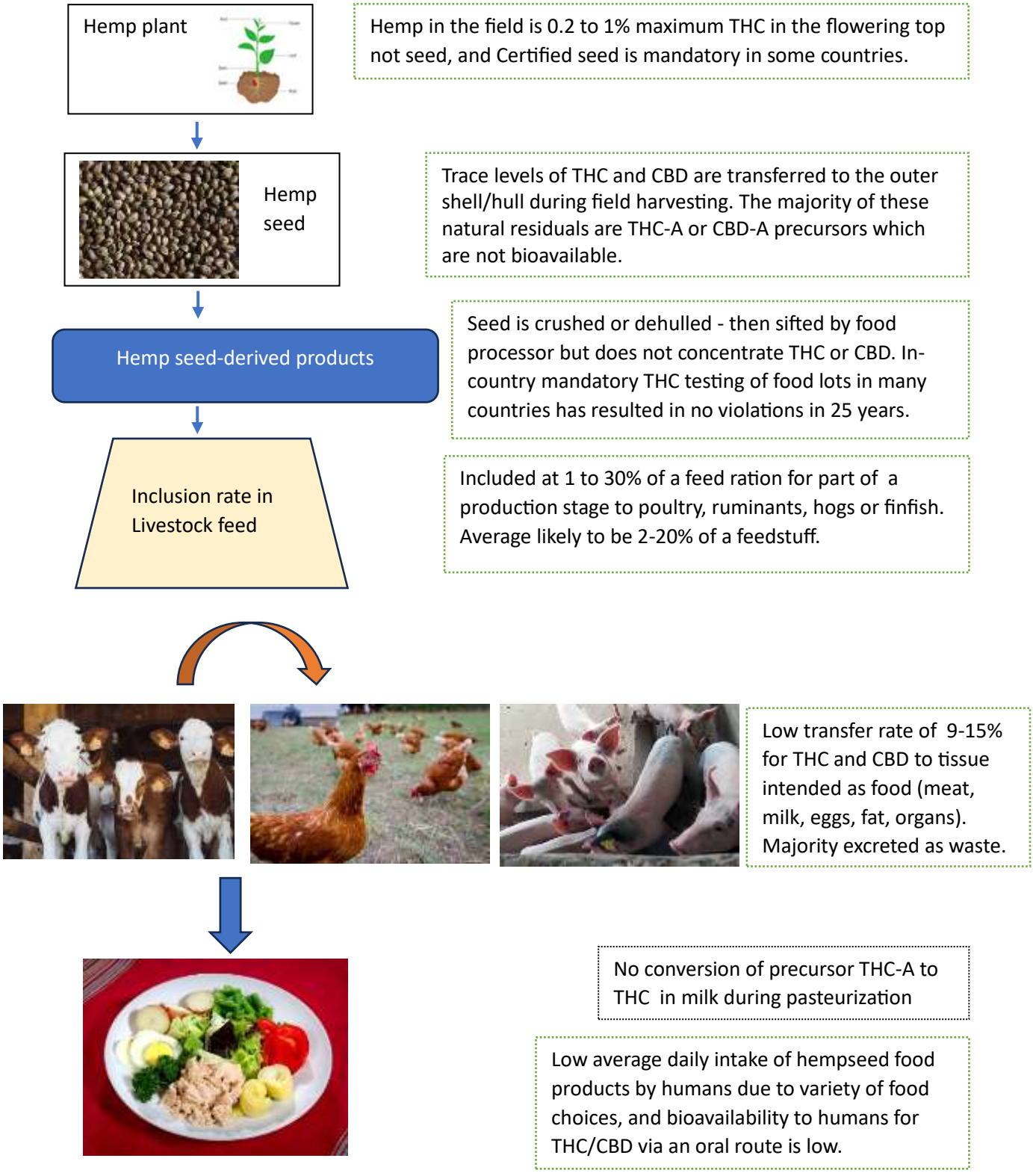
For the above products, regulatory bodies intending to avoid adulterated product may safely identify total CBD level at not more than 200 µg/gram or 200 ppm. At those levels 88 to 90% occurs in the non- bioavailable CBD-A form. The threshold may assist in excluding the addition of a concentrated form of processed cannabinoids not naturally resulting from seed or food processing if that is the intent.
Safe feed ingredients with added concentrates or isolated cannabinoids may have livestock health benefits subject to additional research in the future and/or veterinary health product approval by authorities.

Note: This is based on global research in years 1999 to 2024 for naturally occurring levels of residual THC and CBD in hemp seed as a result of incidental contact when harvesting agricultural hemp crops, and for a maximum hemp plant definition of 1% total THC in the flowering tops. FIHO 2024

One microgram per gram or µg/gram is equal to 1 part per million (ppm)

THC and CBD is effectively reduced in the production chain from seeding of the hemp plant in the field, to processing of seed, to practices by food and feed manufacturers. In addition there are control mechanisms within quality assurance programs, regulatory requirements, extremely low natural residual content, partial inclusion in feed, and in the end, low transfer rate to animal tissue intended as food products.

**Figure 2 – Hemp Seed Production from farmer's field to consumer plate as food**



Industrial Hemp: Feed Definitions

Dehulled hempseed – internal material of the hemp seed. Dehulled hempseed is synonymous with hempseed heart, hempseed nut, and hulled hempseed.

Hempseed fines – fragmented fractions of hemp seed derived from a decortication (dehulling) or mechanical cleaning processes. Comprised of broken hemp seed, broken dehulled hemp seed and hemp seed hulls.

Hempseed hulls – pericarp (hull) of the whole hemp seed used for human or animal food and health-related products. The term is synonymous with hemp seed husks.

Hempseed protein products – products derived from hemp seed by removing the oil content, and categorized by protein content as follows:

- Hempseed protein isolate – protein powder derived from hemp seed with 80% or higher protein content.
- Refined hempseed protein concentrate – protein powder derived from hemp seed between 60% and 79% protein content.
- Hempseed protein concentrate – protein powder derived from hemp seed between 40% and 59% protein content.
- Hempseed meal – protein powder or solid material derived from hemp seed typically between 25% and 39% protein content. The term is synonymous with hempseed cake, hempseed protein meal, hemp seed expeller, hempseed protein cake, hempseed oil cake, and hempseed oil meal. It may reach up to 50% protein content in some countries.
- High fibre hempseed protein – protein powder derived from hemp seed with less than 25% protein content, and considered to be a source of dietary fibre by authorities having jurisdiction.

Hempseed screenings – a composite product containing small whole or broken hemp seeds, weed seeds and other organic material.

Hemp seed (hempseed) – intact achene (fruit) produced from a hemp plant that is capable of normal germination. This is sometimes known as hemp grain or hempseed.

Hemp seed oil – oil derived from hempseed. This oil is low in THC and does not contain added cannabinoids.

Industrial hemp – hemp plant containing low levels of THC in its flowering tops, as determined by authorities having jurisdiction. This is synonymous with “hemp”.