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Pastures and Livestock Build Soil Fertility

Building soil quality and organic matter content are priorities in organic and sustainable farming systems. Raising livestock on pasture is a key cultural practice. As organic farming pioneer Sir Albert Howard keenly observed "Mother earth never attempts to farm without live stock; she always raises mixed crops…" A healthy pasture ecosystem also requires a full complement of essential minerals for plants and animals.

For purpose of documenting how effective pasture based farming systems are at building soil organic matter levels, a survey was conducted to measure soil organic matter under pastureland and plowed row cropland in the Mid-Atlantic region.

Soil samples were collected by sampling the surface 0 to 6 inch layer during the summer months of 2008 to 2010. Some, but not all, of the sampled farming operations were certified organic.

Pastureland (left) versus tilled row cropland (right).

Pasture types represented dairy, beef, equine, and poultry. Row crops included mostly corn and soybean, and sometimes vegetable crops. Each pasture sample was paired to a row-crop sample based on proximity and similarity of soil type.

Altogether 19 paired land management sites (pastureland versus tilled row crop fields) were sampled. Soils were analyzed at the Rutgers University Soil Test Lab using the Walkley-Black method.

Results show that the average soil organic matter content level was 4.0% for pasture and only 2.5% for row cropland (Table 1). The pasture soils were found to hold about 62% more organic carbon than the row crop soils (statistically different at P= 0.01). This accumulated organic matter associated with pastures serves as a reservoir of soil fertility.

Pastured based farming systems build soil organic matter levels more effectively than tilled row crop farming. Pasture forage ideally includes a mix of grasses and legumes. The legume grows on-farm nitrogen and the root density of the grass reduces the leaching of nitrogen from soil.

Such soil building could also be accomplished by growing cover crops. While cover crops do feed the soil, they do not feed animals or people. Pasture and forage crops serve to both feed the soil and at the same time produce nutrient rich food to feed people.

No-till or conservation tillage farming systems are promoted as ways to decrease soil erosion and conserve soil organic matter content. While pasture is not often consciously thought of as a kind of no-till farming system, it functions as such, and provides the same ecological services and probably more.

Soil organic matter is a major storehouse for soil fertility, especially nitrogen. When, or if, pasture sod is eventually broken or tilled for the purpose of rotating to row crop grains or vegetables, accumulated soil fertility is released.

Table 1. Summary statistics for nineteen paired land management sites. Soil organic matter contents in the surface six inches of grazed pasture soils and tilled row crop soils in the Mid-Atlantic region.

Management	**Minimum**	**Maximum**	**Median**	**Mean**
Pasture	2.2	10.4	3.4	4.0
Row Crops	1.6	4.9	2.5	2.5

In such rotations there is generally little or no need for purchase of off-farm nitrogen fertilizers (Fig. 1).

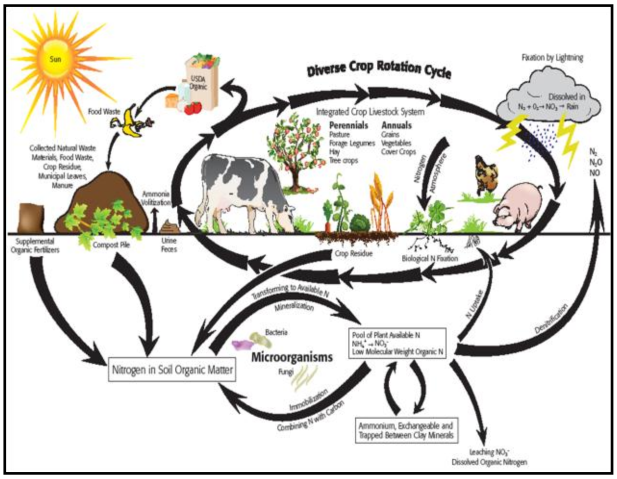

Fig. 1. An ideal nutrient cycle on an organic farm is powered by solar energy and it should be bio-diverse by including mixed plant and animal agriculture and annual and perennial crops as illustrated. In organic farming systems, livestock on pasture play a vital role in building soil fertility and food quality.

A compelling feature of pasture farming is that meat, milk, and eggs produced by animals that graze on pasture have higher concentrations of vitamins and healthful fats. Differences in food quality are sometimes visually apparent as in the case of eggs from chickens in confinement versus pasture as illustrated below. Thus, pasture farming builds both soil fertility and food nutrient density.

Conventional egg (left) with yellow yolk versus a pasture raised egg (right) with orange yolk.

Nutrient Management for Pastured Poultry

Pastured poultry is a system of raising chickens for eggs or meat outside on green pasture. This system is becoming increasingly popular as an alternative to the standard concentrated animal feeding operation (CAFO).

Getting started in pasture poultry production requires limited investment and access to land. Portable pasture pens can be constructed inexpensively from a variety of materials. Working with a small flock is a good way to gain experience before scaling up to a larger, more profitable operation.

Pioneers in the pasture poultry movement have produced some good educational resources. Joel Salatin's book *Pasture Poultry Profit$*, and Andy Lee's book *Chicken Tractor* are now classics.

The American Pastured Poultry Producers' Association (APPPA) http://www.apppa.org/ , established in 1997 is an organization dedicated to sharing information and teaching people how to raise poultry on pasture. ATTRA has several publications of interest to pasture poultry raisers: http://www.attra.ncat.org/livestock.html#Poultry

Keeping backyard poultry in urban and suburban areas has a long history and is on the upswing. Magazines such as, Backyard Poultry or Hobby Farm are dedicated to hobby farmers keeping small flocks. A flock of six to ten laying hens is generally enough to supply all the eggs needed for an average size family.

If one considers that there are about 35 million acres of lawn in the USA, and about 670,000 acres of home owner turf in New Jersey (14% of NJ land area), there is abundant opportunity for keeping small flocks of chickens on grass.

If all 344 million egg layers in the USA were put to pasture on lawn, there would be only about ten chickens grazing on each acre of lawn (an area per bird that considerably exceeds what is necessary).

In New Jersey, the average home owner lot size is about 0.70 acres with 0.32 acres in turf – just enough grass area to accommodate a family flock.

Realistically not every family is interested in keeping backyard poultry and lawns are not the only grassy areas available for keeping chickens. As organic and sustainable farmers step up to meet the increasing demand for pasture raised milk and meat from cattle on pasture, the associated grassland also creates the perfect opportunity to expand into pastured poultry.

As amply demonstrated by Joel Salatin at Polyface Farm, there are advantages to grazing poultry a few days after cattle. In a rotational grazing system, the cattle consumed the taller grass and the chickens that follow feed on the shorter grass. In this multi-species pasture farming, the pastured poultry also provide fly control by feeding on larva in cow manure.

In 2005, I began keeping a flock of egg-layers on my grass lawn in a portable pen. As a soil scientist, I naturally became interested in the flow of nutrients from chicken feed to bird/egg to soil. My concern was about sustainability of nutrient flow and management with pastured poultry. Specialists in soil fertility are often called upon to develop nutrient management plans for commercial farmers.

Nutrient management has much in common with accounting. A nutrient management plan is designed to balance the flow of manure and other plant nutrient sources on to a given land area in a sustainable system. A primary goal is to maintain optimum soil fertility levels while at the same time minimizing the movement of excess nutrients into surface water bodies or ground water. Pollution from excess nitrogen (N) and phosphorus (P) are major concerns.

To illustrate a potential nutrient management scenario for backyard poultry, I used recorded values on feed consumption and egg production from my own flock of brown egg layers (Moyer's hybrid cross between a White Rock egg-layer type female and a Rhode Island Red male).

By measuring daily feed intake, I have found that my two-year old birds consume 0.3156 lbs feed per hen, per day (or 115.2 lbs/hen/year). Also, my birds generally lay large eggs with an average weight of 0.165 lbs or 75 grams per egg. During the summer months when days are long, my birds have an average laying rate of 80% (equivalent to 60 gram of egg per day). But in the winter months when day length is short the laying rate is only about 50% (equivalent to 37.5 gram of egg per day).

For figures on mineral (NPK) composition of feed and eggs, I used average values taken from scientific literature:

Average NPK content of feed = 2.66% N, 0.6% P, 0.84%K

Average NPK content of egg = 1.92% N, 0.21% P, 0.12%K

Estimated NPK intake from feed (g/hen/day) = 3.80 N, 0.85 P, 1.20 K

Assuming an 80% laying rate,

Estimated NPK diverted into 60 gram of egg = 1.152 N, 0.126 P, 0.072 K (g)

Estimated NPK diverted into manure = 2.648 N, 0.724 P, 1.128 K (g)

Estimated diversion NPK of feed to manure: N= 70%; P= 85%; K= 94%

Assuming an 50% laying rate,

Estimated diversion NPK of feed to manure N= 81%; P= 91%; K= 96%

A 50 lbs bag of commercially purchased chicken feed is estimated to contain: 1.33 lbs N, 0.3 lbs P, 0.42 lbs K

Now assume you have a backyard flock of ten chickens; a flock that size will consume about 23 bags of feed per year. Based on the above calculations, it is apparent that most of the NPK contained in the feed is diverted to the manure which in effect is added to the soil over the area that is grazed.

Ten chickens, with a 50% laying rate, pastured on an acre would deposit in one year 24.8 lbs N/acre, 6.3 lbs P/acre (14.4 lbs as P_2O_5), and 9.3 lbs K/acre (11.1 lbs as K_2O).

These amounts of NPK applied in the form of chicken manure do not appear to be excessive, at least in the short term. Even if the chickens were pastured on just a third of an acre instead of a full acre, in effect tripling the application rates of manure nutrients, the NPK rates appear reasonable.

When a lawn is fertilized with commercial N fertilizer at the modest rate of 2 lbs N/1000 sq. ft. per year, this is equivalent to 87.1 lbs N/acre per year. Thus, a backyard poultry flock would likely apply less N per year as manure that a typical lawn fertilizer application.

Keeping backyard poultry also offsets the need to apply any lawn fertilizer. Pastured poultry in rotation with pastured cattle supply nutrients to grow grass to feed cattle.

There are several other factors that could alter the above estimates. For example, when chickens are on pasture they will typically obtain about 10% or more of their feed from grazing green plants and eating insects, and worms. This free local feed offsets the need for purchased feed. This then reduces the amount of imported feed nutrients applied to the lawn/pasture by about 10%.

Another factor not considered in this nutrient management scenario is the amount of feed that the birds may consume during the first 20 weeks of growth before they start to lay eggs. The pullet growth stage would add more nutrients to the soil.

Nutrient management relies on estimates to make predictions about nutrient balance from feed/manure imports and food (egg) exports. It is useful to remember that soil sampling and testing of the land area in question is a good tool to monitor for excessive build up of nutrients. Over the long term, a build up of soil test P might become the greatest environmental concern from repeated applications of manure from grazing poultry.

Should excessive accumulation of P or K from poultry manure ever become a concern, one could re-establish nutrient balance by collecting lawn clippings and exporting them to a composting facility or to ones vegetable garden. Each ton (dry) of clippings would remove from the landscape about 15 lbs N, 2 lbs P, and 9.5 lbs K. Thus, if it became necessary, the export of a few tons of grass clippings for a period of time could offset the balance of imported nutrients from a backyard poultry flock.

Movable Pasture Poultry Pens

The following photo illustrates the pasture pen and portable chicken coop I use to keep my backyard poultry flock. The 5x6 ft coop was constructed over a 4x6 ft wagon bed. Because the floor of the wagon is wire mesh, it allows litter to fall through to the ground, making manure removal from the coop practically unnecessary.

The 6x12 ft. pasture pen is made of PVC pipe. It is light weight and easy to move separately from the coop. Netting covering the top of the pen keeps chickens in and predators out.

As the pasture pen is moved daily, or sometimes more frequently, to a new pasture area, the coop is pushed to it by backing the rear opening up against the gate of the pasture pen. The chickens move freely between the coop and the pasture pen throughout the day.

The coop provides shelter, a place to roost at night, nest boxes for eggs, and a hanging feeder. A water tank is hung outside in the pasture pen in the warm seasons and inside the coop during the winter. Sometimes during severe winter weather, such as snow storms, the coop without the pasture pen is pulled inside a barn.

The book *Chicken Coops* by Judy Pangman, has 45 plans for building portable coops from very small to large.

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