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Urine as a Resource in Nepal

Depleting fertiliser supplies call for alternative nutrient sources. Promising low-cost technologies to recover nutrients from urine were therefore field-tested in Nepal. Bastian Etter[1], Elizabeth Tilley[1], Kai M. Udert[2]

Quest for fertilisers

Over the last few years, Nepali farmers have struggled to meet their crops' quantitative and qualitative fertiliser requirements. While a rapidly growing population demands ever-increasing food production, only limited supplies of fertilisers have trickled into the country. To prevent a decrease in agricultural production and simultaneously reduce dependency on imports, landlocked Nepal is now trying to tap into domestic nutrient sources.

Fertiliser from urine

Thanks to international projects and local initiatives working towards improving sanitation in the country, the number of urine diversion (UD) toilets is rapidly increasing and has allowed for separate urine collection. As urine contains a balanced mix of nutrients, such as nitrogen, phosphorus, potassium, and sulphur, it can be used as a fertiliser after treatment. Over the past three years, researchers from the STUN project have investigated various user-friendly and safe technologies to recover nutrients from urine. This article presents an overview of the tested technologies.

A new bank: the urine bank

Though applying urine directly to crops may be an efficient method to recycle nutrients, UD toilet users without fields are forced to look for other alternatives. In a village near Kathmandu, Nepal, UD toilet users were invited to contribute towards the so-called "urine bank". Farmers could withdraw urine from the bank at a rate determined by the Urine Management Committee [1]. During the initial phase, the "pee-cycle" (a bicycle equipped with two 20-L jerry cans) collected urine from household UD toilets. Currently, the system has evolved and urine will be collected from two schools and transported by tractor to an extended urine bank.

Struvite: concentrated urine

If distance hinders liquid urine transport from urban to agricultural areas, nutrients can be extracted and used in a more concentrated solid form. Up to 90 % of the phosphorus contained in urine can be precipitated in powder form (struvite: $MgNH_4PO_4{\cdot}6H_2O$) after magnesium is added to stored urine. In Kathmandu, a simple reactor was constructed to precipitate struvite and a rotating drum was used to convert the struvite powder into more user-friendly pellets [2]. STUN also explored different magnesium sources accessible in Nepal. Bittern, the waste brine remaining after sea salt production, is efficient but must be imported from India. Magnesite rock is available from a quarry near Kathmandu but must be calcined to form magnesium oxide suitable for struvite precipitation. A microbial risk assessment was conducted to guarantee safety during handling of stored urine and its derived products [3]. With regard to economics, large volumes of urine are required if struvite sales are to cover the production costs. In our case study [4], a struvite producer would have to process at least 7 m^3 of urine a day to be economically self-sufficient. This calculation does not include urine transport costs that may increase total costs markedly.

Aquatic plants store nutrients

As an alternative to soil-based agriculture, STUN researchers used urine and struvite production effluent as a fertiliser in aquaculture, specifically using two species of aquatic plants native to Nepal, *azolla* and *spirodela* [5]. Both plants are rich in protein and can be used for biofuel production.

Drip irrigation with urine

If urine is applied directly (e. g. with a bucket) to the field, a significant part of the nitrogen is lost through ammonium volatilisation. STUN showed that these losses can be prevented if urine or the effluent after struvite production is applied via drip irrigation [6]. However, long-term trials will have to prove that clogging does not occur over time.

Poster promoting the use of urine as a fertiliser in Nepal.

Anammox bacteria in Nepal

If agricultural use of the nitrogen-rich effluent of the struvite process poses a problem, then nitrogen removal should be envisaged to prevent water pollution. Together with local technicians, STUN researchers constructed a rotating biological contactor (RBC) to remove nitrogen via the nitritation-anammox process. This process is particularly suited for nitrogen removal from high-strength ammonia solutions, such as urine.

Further information on nutrient recovery from urine can be downloaded from www.eawag.ch/stun

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