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The effect of intercropping maize with lablab on grain and fodder production in small holder dairy farming systems in Masaka district, Uganda

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Abstract

In a farmer participatory process, farmers in Masaka district, Uganda, identified intensive dairy farming characterized by improved cattle breeds as potentially viable enterprise to enhance income of resource poor households. Inadequate feeds during the dry season is however a major constraint leading to low animal productivity. To alleviate this concern, a study on maize/lablab intercropping was done with the objective to evaluate the effects of intercropping forage legumes with maize on grain and fodder production. Results showed that maize/lablab intercropping increased ($p<0.05$) fodder, grain yields and cob size by 32; 7; and 6% compared to monocrops. Fodder and grain yields were 11 and 2% lower ($p>0.05$) in the short rain season than in long rain season. Crude protein (CP) content and CPY increased ($p<0.05$) 1.2 and 2.2 times in intercrops than monocrops (4% CP and 175 kg/ha). Overall, this study revealed that lablab could be introduced as a component crop in maize cropping systems to improve fodder and food availability.

Key words: *Fodder and grain yield production, lablab, maize, intercropping*

Introduction

In order to improve household nutrition, economies and food security among resource poor households in Uganda, Government and Non Government Organizations (NGOs) have introduced zero grazing dairy cattle production system based on improved or exotic breeds and elephant grass (*Pennisetum purpureum*) as a major forage. This is in line with the country's Plan for Modernization of Agriculture (PMA) policy whose objective is to eradicate poverty through agricultural transformation (Anon, 2005). Zero grazing dairy cattle production has therefore become an important source of milk and has created employment for many resource poor households. This had led to an increase in the demand for feed due to an increase in high genetic capacity of stall-fed dairy cattle breeds.

Although the dairy enterprise is a major source of income contributing about 70% of the total farm agricultural income (Anon, 2005), improved dairy cattle production is constrained by inadequate feeds especially during the dry season (Kabirizi, 1996). Previously, elephant grass fodder has been recommended as a basal feed resource because of its high biomass dry matter yield compared to other grasses, but some studies have shown that its quality and quantity declines during the dry season resulting in protein and energy deficits (Kabirizi *et al.* 2000). Maize is a possible substitute staple food crop in smallholder dairy farming systems in Uganda. The crop produces a lot of stover which could be used as feed during the dry season but the stover is either burnt or used as mulch. This contention is supported by the human population pressure on the land, scarcity of feed during the dry season and high cost of concentrate feeds, long dry seasons in most parts of Uganda, the economic need to match ruminant livestock production systems with available resources and the need to improve food security, justify increased use of maize stover for ruminant animal feeding. However, maize stover is low in protein (about 4% CP) and phosphorus, marginal in calcium and high in fibre and lignin (Mpairwe, 1998). Previously, Abate *et al.* (1992) and Mpairwe (1998) suggested the possibility of maize (*Zea mays* L.)/lablab (*Lablab purpureus* L. Sweet) intercropping to solve the fodder scarcity problem during the dry season. Here, the major objective was to determine the effects of maize/ *Lablab purpureus* (lablab) cv Rongai intercropping on grain and fodder production.

Materials and methods

Study area and selection of farmers

The study was carried out in Masaka district located between 0° 15' and 0°43' South of the equator and between

31° and 32° East longitude. The district has two rain seasons -March to May and September to November. With the exception of a few years of declining trend in precipitation, the annual average rainfall received is between 1100-1200 mm with 100-110 rainy days and an average humidity of 61.2% (Anon, 2003). The average minimum and maximum temperature is 15.8°C and 30.3°C. The soil texture is varied from place to place ranging from red laterite, sandy loam and loam but is in general productive.

The study was conducted in four villages (Kingo, Bütego, Bukulula and Kalungu), Bukulula sub-county of Masaka district. The villages were selected based on the number of farmers who expressed their interest in participating in on-farm research to test improved forage technologies for improved animal productivity. The farm owners were contacted during a baseline survey (Kabirizi, 2002) and expressed their interest in participating in joint on-farm trials. Thirty two households were selected to participate in the trials based on the following criteria i) having a minimum of 0.5 ha of well established and managed elephant grass field (ii) availability of land and labour to plant and manage the fodder fields.

Production, harvesting, sampling and measurement of maize with and without *Lablab purpureus* (lablab)

10 kg of maize (*Longe 1*) and 4 kg of lablab (cultivar Rongai) seed were supplied to each of the 16 households selected. Each farmer planted 0.20 ha of ML and 0.2 ha of maize monocrop (MS). This was during the first (long rains) and the second (short rains) cropping seasons of 2002. Information from Bigirwa, (2004), personal communication; shows that variety *Longe 1* is a cross between *Kawanda Composite A (KWCA)* and an early maturing; short and maize streak resistant, *Population 49*. Unlike *KWCA* that all farmers in Masaka district use, the resultant variety *Longe 1* matures in 120 days (compared to 135 days for KWCA), has medium height of less than 2 m; less prone to lodging and is maize streak resistant. Under good management *Longe 1* yields 4-5 t/ha of grain. On average farmers get 2.5t/ha without fertilizers.

Maize was planted at 75 cm x 50 cm as recommended (Imanyoha *et al.*, 2000). Within three weeks after germination of the maize seed (Mpairwe, 1998), lablab seed was introduced into maize crop rows at spacing of 1m x 1m. Maize was harvested at physiological maturity, 120 days after germination of the maize seed when the cobs were dry but the stover was still green (Imanyoha *et. al.*, 2000). Maize/lablab stover (ML), stover from maize monocrop (MS), cobs and grain yields were estimated on whole plant basis using 3 quadrates of 1 m x 1 m randomly selected from the middle of the fields from 6 randomly selected households. The average number of cobs per plant, mean weight of cobs, grain, lablab and stover yield from each quadrate was recorded. The ML and cobs from the quadrates were harvested and weighed and the material was separately. After harvesting the dry cobs, the above ground plant material from the intercrop (stover and lablab) were harvested as animal feed, air-dried and later stored on well ventilated racks that were constructed by the farm owners. The racks were constructed below the roof of the cowsheds. Samples of about 0.3 kg of stover and lablab from ML and samples of stover from monocrop were taken, weighed and dried at 60°C for 72 hours. The dried samples were used for DM estimation, chemical analysis and *in vitro* dry matter digestibility (IVOMD). The grain and stover yield from each household was recorded.

Chemical analysis

Samples were weighed, ground, sieved through a 1 mm sieve and stored in airtight bottles. Samples were analyzed for crude protein (CP) following A.O.A.C. methods (1990). Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were analysed as described by Van Soest and Roberts (1985); *In vitro* dry matter digestibility (IVDMD) by the Tilley and Terry (1963). Crude protein yield was calculated as the product of fodder DM yield and CP%. Calcium (Ca) and Phosphorus (P) contents were determined by first digesting the samples with a tri-acid mixture of surphuric acid, perchloric and nutric acids. In series, Ca was assayed using an atomic absorption spectrometer and P content was determined using the ascorbic acid procedure (Okalebo *et. al.*, 1993). Metabolisable energy (ME) was estimated using a regression equation developed by Close and Menke (1986) where ME (MJ/kg DM) = 0.15*IVDMD%. Crude protein yield (CPY) was calculated as the product of DM yield and CP percentage.

Statistical analysis

Maize grain yield; fodder DM yield (lablab. ML, and maize stover from monocrop and intercrop) and chemical components (CP, CPY; IVOMD; ME; Ca; P and ME) of the fodder were subjected to statistical analysis using a General Linear Model procedure for Randomized Complete Block Design using SAS (1999). The data collected were subjected to analysis of variance (ANOVA). The model used in the analysis was:

$Y_{ij} = \mu + P_i + S_j + H_k + PS_{ij} + e_{ijk}$, where Y_{ij} = fodder or grain yield or chemical composition,

μ= Overall mean; P=Effect of ith Practice (P), 1-2 (monocrop: intercrop); S=j^{th} Season [dry and wet]; H_k = k^{th} Household/ plot (4 households x 3 plots); PS_{ij} = the interaction between the ith Practice at j^{th} Season; e_{ijk} =Random error Comparisons of means were considered significantly different at ($p<0.05$) using the Least Square Means Method.

Results and discussion

Effects of intercropping lablab with maize on fodder DM and grain yield

Field observations showed that during the first month after introducing lablab seed into the maize crop, lablab plants grew slowly competing with weeds between maize rows, but not with the maize plants. When the maize plants began to tussle, lablab vines started to grow more vigorously and obtained their greatest development a month before the maize cobs were harvested. The effects of intercropping

maize with lablab on fodder DM and grain yields are presented in Table 1. The proportion of lablab in the intercrop was about 24%. Intercropping maize with lablab increased ($p>0.05$) maize stover DM and grain yield by about 5 and 7%, respectively compared with the monocrops. Total fodder DM, grain yields and cob size were about 32%, 7% and 6% higher ($p<0.05$) in intercrops than in maize monocrop, respectively. Total fodder dry matter (DM) and grain yields in intercrops were about 11% and 8% lower ($p<0.05$) during the second (season short rains) when compared to the first season (long rains). There were no differences ($p>0.05$) in maize stover DM and grain yields between the monocrops and the intercrops.

Improved total fodder (maize stover + lablab, (ML) DM yields could be attributed to higher proportion of lablab in the intercrop and efficient utilization of water resources and soil nutrients in ML intercrops. It could also be due to less competition between the growing maize and lablab plants and the weeds. Two months after introducing lablab into the maize crop, lablab plants provided a soil cover, thus reducing water loss from the soil by evaporation. It also controlled the weeds that could have competed with maize and lablab plants for soil nutrients and moisture. The high proportion of lablab reported in this study could be attributed to its ability to withstand drought compared to maize plants. Because of its deep-rooted nature (Thomas and Dabas 1982), lablab plants were able to tap water and nutrient resources deep in the soil profile. Therefore, higher total fodder DM yield in intercrops was not only due to higher total (lablab + maize) plant population densities but also to yield advantages that accrued basically from a lower competition and edaphic space in monocrops.

Table 1. Effects season on grain and fodder DM yields of maize intercropped with lablab.

	First season 2002		Second season (2000)	
	Cropping season		Cropping system	
Parameter	**MS**	**ML**	**MS**	**ML**
Lablab	-	1443.8 ± 93.9 7	-	1198.6 ± 154.23
Stover	4575.0±238.83	4362.±286.34	4171.9±294.53	3966.9± 279.50
Total	4575.0±238.83	58006.3±323.45	4171.9±294.53	5118.8±413.57
Grain	2979.4±208..18	3245.0±233.63	2845.5±319.50	2985.7±324.69
No. of cobs/sq.m	5.3 ±0.28	5.7±0.34	6.7±0.55	6.9±0.47
Mean weight of cobs (g)	128.3±4.69	137.7±5.76	139.2±6.11	145.5±5.77
Change in grain yield (%)	-	8.7±1.90	5.6±1.1	-
Proportion of Lablab (%)	-	32.0±1.73	-	27.3±2.60

SEM= Standard error of the Mean; MS: maize monocrop; ML maize/lablab intercrop

Results of improved fodder DM yield obtained in this study wereconsistent with those of Mpairwe (1998), Katuromunda (2001) and Roothaert (2003) who showed that intercropping cereals with forage legumes improves total fodder DM yields by 7-25%. The relatively lower DM yield of maize stover in intercrops compared to mono crops could be due to the smothering effects of lablab vines on the maize stalks during the third month after planting the maize seed. During that period, lablab vines grew vigorously twining around the maize stalks and this could have lowered the yield ofthe maize stover.

Results of enhanced grain yields (11 to 73%) from various cereal/legume intercrops have been reported by Kusekwa *et al.* (1992) and Katuromunda (2001). However, several studies by Nnadi and Haque (1990); Mwebaze (1996) and Mpairwe (1998) reported a depression of 7 to 24% in maize streak virus which is a major constraint in all maize production systems in Uganda (Imanyoha *et. al.,* 2000). Acland (1971) cited in Nnadi and Haque (1984) observed that when are commended cultural practices are applied, the yield of maize grain for one season rose by about 308% where weeding was done once, planting one month after the optimum date and without fertiliser.

The higher weight of the cobs during the second season could have been due to N fixation by lablab. It has been reported that the N fixed by the legume component may be available to the companion crop during the same season or may be available during the succeeding cropping season (Agboola and Fayemi, 1977). Thus, intercropping maize with forage legumes at the appropriate time with the

recommended agronomic practices can offer a potentially simple way of increasing the feed resource base (ML stover and maize bran) and food (maize flour and maize cobs) production with mimimum inconviniences or changes in the recommended agronomic practices of smallholder farmers whose major constraint is land shortage.

Results of the feeding trials (Kabirizi, 2004) showed that mean daily dry matter intake of ML was 4 kg. According to Humphreys (1991), the required daily allowance of ML would be about 9 kg DM of ML. Assuming a mean DM yield of 5485.8 kg ha/year of ML (Table 1), the quantity of ML produced from 0.4 ha/year would be about 2,194.3 kg DM. This quantity of fodder would support a mature cow producing about 13 litres/day for about 247 days (about 8.4 months). A study conducted at ILRI, Ethiopia (ILCA, 1991) showed that intercropping wheat and vetch forage crop provided enough high quality feed to support a crossbred dairy cow producing an average of 4 kg/day of milk for up to 13 months.

Effects of intercropping *Lablab purpureus* with maize on chemical composition of ML stover

Results on the effect of intercropping maize with lablab on chemical composition and *in vitro* dry matter digestibility (IVDMD) of fodder are presented in Table 2.

Table 2: **Mean crude protein content and chemical composition of fodder during the two seasons, 2002**

	Stover type			
Parameter (% DM basis)	ML stover	Lablab	MS from intercrop	MS from monocrop
Organic Matter	90.9±0.16	91.2±0.16	90.6±0.22	90.8±0.18
Dry matter	49.2±1.26	49±1.57	66.3±4.42	49.8±2.34
CP	7. 7±0.13	18.7±0.35	6.2±0.15	4.0±0.06
Cry (kg/ha/year)	432.0±20.1	283.6±18.0	258.6±12.3	180.0±7.7
Ash	9.3±0.07	9.7± 0.32	11.1± 0.33	9.2+0.33
NDF	60.8±1.82	46.1±0.69	65.7± 0.90	62.5±0.76
ADF	40.1±1.14	40.5±2.14	40.91.02	41.0±1.22
Ca	0.36± 0.03	0.51± 0.03	0.28±0.03	0.33±0.03
P	0.50±0.02	0.58±0.02	0.39± 0.03	OA4±0.03
IVDMD	58.8±1.92	62.5±1.61	55.6±1.27	55.2±1.27
#ME	9.0±0.16	94±0.18	8.7±0.14	8.6±0.14

It was assumed according to Close and Menke (1986) that ME = 0.15*IVDMD; MS =Maize stover

Intercropping maize with lablab increased ($p<0.05$) CP content and total cry from maize/lablab intercrop, as compared to maize monocrop. On average, the CP content was 1.9 times higher in intercrops when compared to the monocrops. Maize/lablab intercropping reduced ($p<0.05$) OM, DM and NDF but increased ($p<0.05$) P; Ca; IVOMD and ME compared to maize monocrop.

The improvement in CP and cry in the intercrops could have been due to the transfer of N from lablab to the maize plants. According to Agboola and Fayemi (1977), the N fixed by the legume component might be available to the companion crop during the same season or may be available during the succeeding crop season. The issue of transfer of N from legumes to companion crops is therefore of great importance where no fertilizers or very little fertilizers are used and the soil is very low in organic matter. Improved CP content in intercrops could also be due to higher proportion (24%) of lablab in ML. While CP content of lablab was 18.6%, that of maize stover was only 4%. Improvement in the quality and quantity of ML is therefore the key factor to increasing the nutritional value of maize stover for the dairy cow during the dry season. Although CP content of ML was above the minimum level (7% CP) recommended for moderate growth (NRC, 2001), it was lower than reported by Mpairwe (1998) in ML (8.6% CP). The differences in the results of the trials could be attributed to chemical fertilizers 100 kg/ha of diammonium phosphate (DAP) that was applied at planting time and 50 kg/ha of urea applied as top dress, six weeks after planting or to the maize variety. Phosphorus is an important nutrient in the successful establishment of forage legumes (Satter and Wu, 2000) and its deficiency affects N fixation in legumes through its effects on nodule development and nodule

fixation and plant growth and hence increases N or CP content and P concentration uptake by the plant.

The higher Ca and P contents and IVDMD in the intercrops were attributed to presence of lablab legume which has been reported to have higher Ca and P contents (1.7 Ca and 1.6 P) compared to maize stover (Kabirizi, 1996). Lablab had a higher CP with a lower NDF content (<60%) than maize stover. Singh and Oosting (1992) categorized feeds with NDF contents ranging between 45 and 65% as medium quality feeds and those with NDF below 45% as high quality feeds.

Therefore, the feeds obtained from maize/lablab intercrop and maize mono crop were of medium quality.

Despite the high labour required to harvest, transport, conserve and store the stover, farmers ranked ML as the most important dry season feed that should receive more research interventions because of its ability to feel the feed gaps during the dry season. Meanwhile, the technology of ML intercrop that was hitherto uncommon in the district is spreading fast because of the apparently obvious advantages of better quality and quantity feed and improved household food security and income. Information from the District Extension Coordinator, Masaka (Mayega(2004), personal communication) showed that land devoted to ML has increased markedly by about 15%. This might be due to the combined effects of higher grain yield, higher quantity and quality of ML production, and because it demanded little cash working capital.

In conclusion, this study has shown that ML technology is of particular importance to resource poor crop/livestock farmers for it would provide improved fodder production to fill the feed gap during the dry season while improving maize grain yield from the same piece of land. Improving forage DM yield and or forage quality without adversely affecting grain yield is an attractive option for smallholder mixed crop/livestock systems where livestock is inadequately fed and land to grow food and forage crops separately has remained a major constraint. Improved feed supply would have a positive effect on milk yield, growth and reproductive performance. Other important contributions such as erosion and weed control were not measured. These additional contributions may positively influence adoption of the technology. Hence efforts should be made to quantify these benefits in future on-station and on-farm investigations. The results of the study have shown that CP levels and energy levels in ML were less than the levels recommended for the growth and production of a lactating dairy cow (NRC, 2001). Thus feeds from ML intercropping systems when fed alone may not be able to support very high levels of production especially in lactating dairy cows. Legume enrichment, for example with lab lab and/or calliandra leaf hay and a concentrate has been suggested as possible methods of improving the forage quality.

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References

Abate, T.; Tekalign, M. and Getinet, G. 1992. Integration of forage legumes into cereal cropping systems in Vertisols of the Ethiopian highlands. *Trap. Agric.* 59: 68-72.

Agboola, A.A.; Fayemi, A. A. 1977. *legumes.Agran. J* 66:409-721.

Fixation and excretion of nitrogen by tropicalAnon, 2001. Plan for Modernization of Agriculture: Eradicating Poverty in Uganda. Government Strategy and Operational Framework. Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Entebbe and Ministry of Finance, Planning and Economic Development (MFRED), Kampala.

Anon, 2003. Masaka district Local Council Annual Report, 2003.

Anon, 2005. Uganda Population and Housing Census Report. Uganda Bureau of Statistics. Ministry of Finance, Planning and Economic Development.

A.O.A.c. (Association of Official Analytical Chemists) 2001. Official Methods of Analysis 15th Edition, 2200 Wilson Boulevard, Arlington, Virginia 22201, USA.

Close, W. and Menke, K. H. 1986. Selected Topics in animal nutrition. A manual prepared for the 3rd Hohnheim Course in Animal Nutrition in Tropics and Sub-tropics 2nd ed. 74-85 pp.

Imanyoha, J.; Kyetere, D.; Bigirwa, G. and Kikafunda, J. 2000. Application for release of four maize varieties. Cereals Programme. Namulonge Agricultural and Animal Production Research Institute.

Kabirizi, J. 1996. Productivity and feeding value of *Lablab purpureus* cv. Rongai for lactating dairy cows fed elephant grass based diet. MSc Thesis. Makerere. University.

Kabirizi, J. M.; Bareeba, F. B.; Sabiiti, E.N.; Namagembe, A.; Kigongo, J. 2000. Effect of supplementing crossbred dairy cattle fed elephant grass based Diet with lablab hay and a concentrate. *Ug. Journ. Agric. Se.* Vol. 5: 9-16.

Kabirizi, J. 2002. Utilization of forage and fodder crops in zero grazing dairy cattle production systems in Masaka district, Uganda. Progress report. July 2003.

Katuromunda, S. 2001. Compatibility and Productivity of forage legumes with maize and elephant grass in peri-urban smallholder crop/livestock production systems. MSc. Thesis.

Kusekwa, M.L.; Bitende, S.N. and Ngowi, N. D. 1992. Productivity of oversown pastures in northern Tanzania. In: Dzowela, RH.; Said, A.N.; Wendem-Agenehu, A.; and Kategile, lA. (eds.). *Utilization of Research Results on Forage and Agricultural By-product Materials as Animal Feed Resources in Africa.* PANESA/ARNAB (Pastures Network for Eastern and Southern African Research Network for Agricultural By-products). Proceedings of the First Jointworkshop held in Lilongwe, Malawi, 5-9 December 1988. PANESA/ARNAB, Addis Ababa, Ethiopia. pp 833.

LSRP (Livestock Systems Research Programme) Report, 2000. District Diagnostic Survey Reports. Livestock Systems Research Programme (NARO/DANIDA/ LSRP). Draft summary report.

MFPED. 2003. (Ministry of Finance, Planning and Economic Development). 2003. Population Census Report, 2003.

Mpairwe, D. 1998. Integration of forage legumes with cereal crops for improved grain yield, forage production and utilization for smallholder dairy production systems. Ph D. Thesis. Makerere University.

Mubiru, S.; Ebong, C.; Rubaire-Akiiki, c.; Kabirizi, J.; Odur, A.; Ndyanabo, Niels; W.; Namagembe, A.; Mayega, L.; Nakatudde, P. and Luvumu, E. 2001. Effect of forage legume on growth and biomass yield of elephant grass. *Paper presented in NARO Scientific Workshop held at the International Conference Centre, Kampala, Uganda. 2nd to ih December 2001.*

Mwebaze, S.M. 1996. Biomass production of maize *(Zea mays)* intercropped with selected forage legumes for food and feed in smallholder farming systems. M.Sc. Thesis, Makerere University, Kampala.

Nnadi L. and Haque I. 1988. Forage legumes in African crop/livestock production systems. *ILCA Bulletin* 30:10-19. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Ofori, F. and Stem, RM. 1986. Maize/cowpea intercrop system. Effect of nitrogen fertilizer on productivity and efficiency. *Field crops Research* 14: 247-251.

Okalebo, J. R; Gathua, K. W. and Woomer, P. L. 1993. Laboratory methods of soil and plant analysis. A Working Manual. Tropical Soil Biology and Fertility Programme. UNESCOROSTA, Nairobi, Kenya, pp. 88.

SAS (Statistical Analysis Systems Institute Inc. 1999). Statistical analysis Systems Institute (SAS/STAT). User's Guide. Version 8, Carry, NC: SAS Institute Inc; 1999. pp. 3884.

Satter, L.D. and Wu Z. 2000. Balancing the animals' nutritional needs with environmental stewardship. *Advances in Dairy Technology* 12: 43-57.

Singh, K. K. and Rathi, K. S. 2003. Dry Matter Production and productivity as influenced by staggered sowing of mustard intercropped at different row ratios with chickpea. *J Agron. and Crop Sci.* 183: 169 - 170.

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(ii) For periodicals.

Bekunda, M.A., Smethurst, P.J., Khanna, P.K. and Willet, J.R., 1990. Effects of post-harvest residue management on labile soil phosphorus in a *Pinus radiator* Plantation, *Forest Ecology and Management*, 38:13-25.

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Swift, M.J., Bohren, L., Izac, A.M. and Woomer, P.L., 1994 Biological management of tropical soil: Intergrating process research and farm practice. In: P.L. Woomer and M.J. Swift (Editors). *The Biological Management of Tropical Soil Fertility*. John Wiley, Chickester, UK, pp. 209-227.

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