DEVELOPMENT OF A NEW GARLIC SEEDER[1]

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ABSTRACT - A garlic seeder prototype was developed using a conveyor lug belt as a clove distribution system. Two sprocket wheel combinations 46:17 and 46:26 were used on the machine performance evaluation. For both sprocket wheel ratios the garlic clove distribution on the soil were practically the same. The percentage of long spacing (gaps) and short spacing (double cloves) between two cloves was bigger than that obtained by conventional precision drill. The percentage of acceptable spacing hill this drill could have been bigger if the glove size had been more uniform.

DESENVOLVIMENTO DE UMA NOVA PLANTADEIRA DE ALHO

RESUMO - Um protótipo de uma plantadeira de alho foi desenvolvido usando uma correia dentada como sistema distribuidor de bulbilhos. Duas relações de velocidade, 46:17 e 46:26, foram usadas na avaliação de desempenho do equipamento. A distribuição de bulbilhos no solo foi a mesma, praticamente, para ambas relações de velocidade. As percentagens de espaçamentos superiores (falhas) e inferiores (bulbilhos duplos) aos aceitáveis foram maiores que as encontradas na literatura. A percentagem de espaçamentos aceitáveis poderia ter sido maior se os bulbilhos tivessem sido mais uniformes.

Garlic producing Brazilian farmers have been trying to produce more garlic in the recent years to obtain self-sufficiency by utilizing their own technology and also expanding the cultivated area for garlic.

Some equipments such as garlic seeder are developed for garlic mechanization. However, they are not available in the market, because most of them are developed by the farmers themselves, and they are not precise.

The garlic sowing is made depositing cloves in the furrow in an acceptable spacing. Normally in Brazil the garlic sowing is made in a row spacing of 250 to 300 mm and spacing hill in a row of 80 to 100 mm with 30 to 50 mm depth. Planting operation includes the opening of furrows, fertilizer distribution and mixed soil in the furrow, clove seeding and finally the covering of the

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cloves. The manual operation takes about 370 h/ha, while the mechanical operation takes about 11 h/ha (Menezes Sobrinho 1984).

The garlic average yield in Brazil is approximately 4 ton/ha (Fundação IBGE 1983). However, if a farmer can manage good cultivation under the best climate and sufficient soil condition, it is possible to obtain an average production of 10 to 12 ton/ha. The high productivity and economic value of garlic in Brazil is one of the most profitable vegetable crops.

The main objectives of this work were to develop a one-row garlic seeder manual prototype, to evaluate the clove distribution system.

The garlic seeder prototype (Fig. 1 and 2) was assembled on two bicycle wheels of 508 mm diameter. The rear wheel drives the movement of the clove distribution system by a sprocket wheel $Z_1 = 46$ teeth. In this case, the rear wheel also function as a clutch system. The clove distribution system can stop to work any time and the machine can continue to move.

The metering device was made of two parts:

The first is the conveyor lug belt with length of 1833 mm, width of 47 mm and thickness of 5 mm. It is joined by using belt lacing and it has 35 foam lugs with length of 25 mm, width of 47 mm and thickness of 25 mm. They are glued and uniformly distributed from 26 to 26 mm on the belt flat surface.

The second is the speed transmition system. It is made of three pulleys with inner diameter of 45 mm, just one is the belt driving pulley and they are made of plastic material. It still has a piece with two united sprocket wheel, one $Z_2 = 17$ teeth and another $Z_3 = 26$ teeth. The belt driving pulley and the united sprocket wheel are assembled on the same shaft with diameter of 16 mm and length of 280 mm. This shaft is fixed by both sides in the support plate.

The clove conveyor belt was designed to get equal clove spacing for the japanese garlic variety, namely "White Rokuhen", whose average size is 38 mm of length and 26 mm of thickness.

Therefore, the clove nominal spacing can be calculated as follows:

Taking the diameter of the rear wheel $D_1 = 508$ mm, the machine linear displacement for one rotation of wheel was:

$$\pi * 508 \text{ mm} = 1596 \text{ mm};$$

Taking the number of teeth on the driving sprocket wheel $Z_1 = 46$, the number of teeth on the smaller driven sprocket wheel $Z_2 = 17$ and when the wheel rotates once, the number of rotation of the smaller driven sprocket wheel was:

$$\frac{46 \text{ teeth} * 1 \text{ round}}{17 \text{ teeth}} = 2.7 \text{ rounds};$$

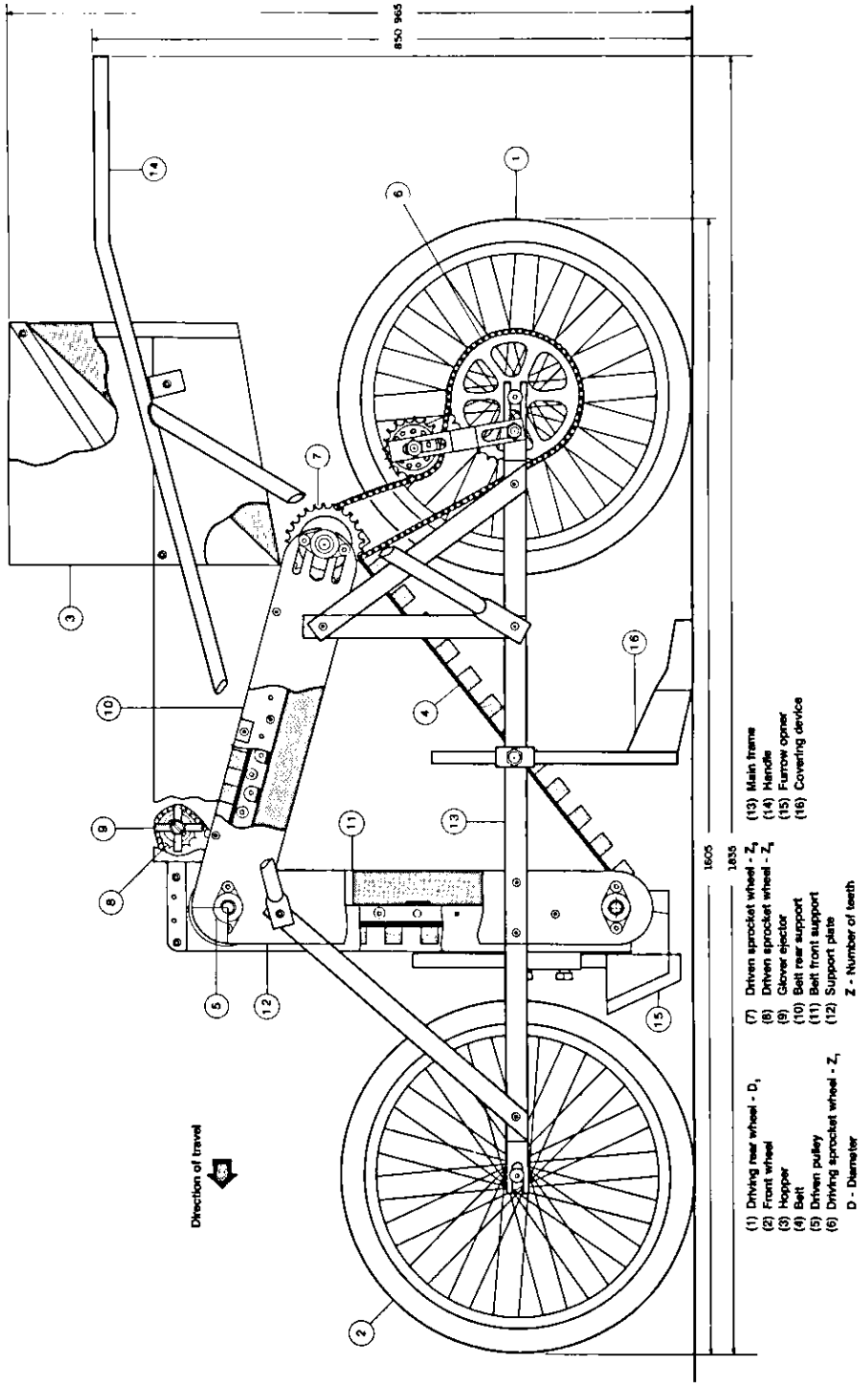

FIG. 1. Garlic seeder side view.

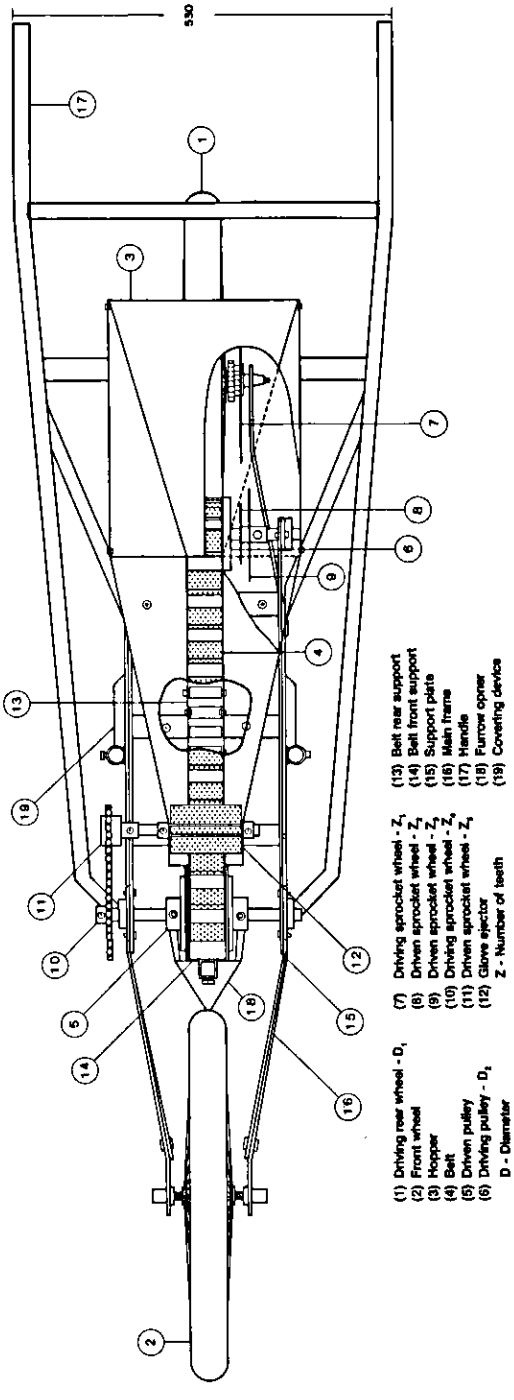

FIG. 2. Garlic seeder top view.

And consequently the number of rotation of the pulley was 2.7 rounds;

The belt driving pulley D_2 = 45 mm diameter, then the linear displacement of the belt was:

π * 45 mm * 2.7 rounds = 381,70 mm;

The belt lug pitch is 52 mm; in this case, 1 mm is added for the belt tension, then the number of the dropped for one wheel rotation was:

$$\frac{381{,}70 \text{ mm}}{52 \text{ mm}} = 7{,}34 \text{ cloves;}$$

Therefore, the theoretical linear density of cloves was:

$$\frac{7{,}34 \text{ cloves} * 1000 \text{ mm}}{1596 \text{ mm}} = 4.6 \text{ cloves/metre;}$$

Or the clove nominal spacing is 217,4 mm.

And considering the same calculation procedure for the bigger driven sprocket wheel Z_3 = 26 teeth, the clove nominal spacing was 331,7 mm.

The clove ejector was made of four foam pieces with length of 100 mm, height of 28 mm and thickness of 15 mm each one. They were glued on a pipe shaft with diameter of 16 mm and length of 382 mm and rotate in opposite direction of the belt movement. They were designed to avoid that one more clove fit inside of the same belt lug pitch, and reach the furrow.

The clove ejector rotation was in function of the belt rotation. When the number of rotation of the smaller sprocket wheel (Z_2 = 17 teeth) was 2.7 rounds, the number of rotation of the driving sprocket wheel (Z_4 = 28 teeth) is 2.7 rounds too, and the number of rotations of the driven sprocket wheel (Z_5 = 14 teeth) was:

$$\frac{28 \text{ teeth} * 2.7 \text{ rounds}}{14 \text{ teeth}} = 5.4 \text{ rounds}$$

And considering the same calculation procedure for the bigger sprocket wheel (Z_3 = 26 teeth), its rotation was 1,77 rounds. Therefore, the number of rotation of the driven sprocket wheel (Z_5 = teeth) was 3.6 rounds.

The garlic seeder performance test was done by the sprocket wheel combination between the number of the teeth on the driving sprocket wheel Z_1 and on the smaller driven sprocket wheels Z_2 and Z_3 equivalent 46:17 and 46:26 are considered the treatments.

TABLE 1. Spacing distributions obtained for garlic clove on the field.

Treatm. K	Nominal spacing S (mm)	Number of observat.	% spacing		
			Acceptable 0,5 - 1,5S ($\bar{X} \pm CV$)	Doubles <0,5S	Gaps >1,5S
46:17	217,4	113	66(213,0±0,18)	14	20
46:17	217,4	115	70(211,0±0,23)	21	9
46:17	217,4	110	56(209,7±0,25)	26	18
46:26	331,7	108	57(323,4±0,20)	15	28
46:26	331,7	113	72(322,3±0,21)	19	9
46:26	331,7	111	64(320,1±0,24)	20	16

K - Sprocket wheel combination between the number of the teeth of the driving sprocket wheel Z_1 and of the driven sprocket wheels Z_2 and Z_3.

X - Field average spacing (mm).

Each treatment consisted of three replications of clove spacing along of 2429 mm length (46:17), and 3771 mm length (46:26).

The distance between the cloves was measured by a tape measure. The results are shown in Table 1 and they were compared with Ward - 1981 datas. In this study three categories are used, namely zero S (<0,5 S) corresponding to doubles, S (0,5 - 1,5 S) corresponding to a clove acceptable spacing and 2S (>1,5 S) corresponding to gaps.

The garlic seeder performance was affected by some problems during the test, such as:

Not uniform clove size, eventually two or more small one might fit inside the lug belt pitch. After that, they could pass by the clove ejector and brake or ebb the belt movement into the belt from support;

The sprocket wheel combination 46:26 has caused any interruption during the machine displacement, because this ratio has provided low speed of the clove distribution system and the clove ejector system. Namely, they have not had sufficient dynamic energy to overcome this kind of resistance;

The upper part of the hopper has not gotten to release the most of the cloves, step by step, to lower part of the hopper. Then, they have caused a big riot around the glove ejector. And when the clove volume has decreased, many cloves were stopped on the flat bottom of hopper and they have not followed naturally in the belt.

Ward (1981) worked with two kinds of small vegetable crop seeds and tested two different sowing techniques; one of them is the fluid drilling and the other is the precision mechanical

sowing. He made tests in laboratory and on the field.

The results presented in Table 1 reveal that the clove acceptable spacings on the field, varied from 56 to 72%, doubles from 14 to 26% and gaps from 9 to 28%.

Practically these data provide the same results than that of the precision drilling tested on the field by Ward (1981), which reveal acceptable spacings from 57 to 67%, doubles from 5 to 16% and gaps from 26 to 33%. Nevertheless, they do not present the same spacing distribution precision like the date of the precision drilling tested in the laboratory by Ward, which reveal acceptable spacings from 86 to 96%, doubles from 1 to 6% and gaps from 3 to 8%.

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REFERENCES

FUNDAÇÃO IBGE, Rio de Janeiro, RJ. **Censo agropecuário.** Rio de Janeiro, 1983. v.2, t.3, n.1, 492p. (IBGE. IX Recenseamento Geral do Brasil, 1980).

MENEZES SOBRINHO, J.A. de; LOPES, C.A.; REIFSCHNEIDER, F.J.B.; CHARCHAR, J.M.; CRISÓSTOMO, L.A.; CARRIJO, O.A.; BARBOSA, S. **Cultivo do alho (*Allium sativum* L.)**, 2.ed. Brasília, EMBRAPA-CNPH, 1984. 16p. (EMBRAPA-CNPH. Instruções Técnicas, 2).

WARD, S.M. Performance of a prototype fluid drill. **Agric. Eng. Res.**, **26**(4):321-31, 1981.