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# Participatory Variety Selection of Field Pea (*Pisum sativum* L.) and Apparatuses to Understand Farmer's Selection Criteria in Eastern Arsi Zone of Ethiopia

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**Abstract:** Field pea is one of the protein rich grain food legumes that have a lion share in human diet in Arsi zone. It is a long time ago that field pea crop improvement started in which more than 16 new varieties released those are selected primarily for yield potential, but there is a traits left considered as a very import by majority of farmers. This study intended to recognize farmers important traits consider for decisive varieties to grow. The study was conducted at south eastern Arsi of Ethiopia, representing five major field pea producing location, in one growing season, using a participatory variety selection approach. A total of nine improved and one local check field pea varieties are used. Majority of farmers' were found around fourteen traits that can influence the selected varieties across all location. There is also some traits those are more sensitive to gender difference. Among fourteen traits, nine were considered very important in one or all of the location in a growing season. Unfortunately there are preferred traits that are not given high priority by the current field pea breeding program in Ethiopian. This study indicated that there is no field pea variety possesses all desirable characteristics that meet the diverse farmers' selection criteria that adapted to varied location and a growing season. It is better if farmers' preference traits would be considered in breeding program for a country Ethiopia where the crop is consumed as a stable food.

**Keywords:** Field Pea, Traits, Location and Variety

## 1. Introduction

Pulse crops conquer an irreplaceable place in global agriculture through asset of highly nutritious and a huge share on contribution on atmospheric nitrogen fixation. Among the pulse crop field pea (*Pisum sativum* L.) is the one which is grown widely as a worldwide and currently lines among the four anterior pulse crops with cultivated areas of 7.8 million hectares. In Ethiopia the crop is widely grown in mid to highland and ranks fourth per the area coverage attainment of 8,141,031 ha with an annual production of 3, 481, and 44.631 [7]. It is the major food legumes with valued and inexpensive sources of protein taking prolonged vital amino acid (21-26%) that ensure high dietary tenets for resource poor households [10, 19]. The crop has a significant role in soil fertility restoration and serves as a break crop suitable for rotation to minimize the negative impacts of cereals based on mono cropping [21, 11, 9]. It also used as bases of income for the farmers and foreign currency for the country [8, 20]. Within this all facts the average yield of the crop is only 1.7t $ha^{-1}$ in Ethiopia [23]. Still, it fluctuates and beneath the potential as compared to the World production of 2t per hectare [7].

Exclusive farmers' participatory ways of variety selection process is the main problems behind in sufficiency of improved varieties with wider adoption rate, agronomic practice, diseases and insect pests. In other hand to address the needs of smallholder farmers, some improved field pea varieties has been released by the different regional and federal research centres as a country level since 1979 [16]. Those varieties were selected based on four major criteria – high yield potential, good ascochyta blight resistance, good

powdery mildew resistance, and wide adaptation – and targeted the main rainy season (known as Meher), where ascochyta blight, powdery mildew is the primary production constraint. With respective of this, several factors may account for the limited adoption of new varieties. First, mismatch of breeder's selection criteria with grower's preference. There is a possibility of multiple traits consideration by some farmers for their diverse needs. Similarly [24, 22], reported as farmers' selection traits are multivariate in nature. But currently breeders in Ethiopia are limited to specific traits near different agro-ecological zones. For a crop like field pea, endogenous biased traits were also helping to decide the recognition of a variety. These traits can be defied for breeders to expressively gauge unless there is a close cooperation with farmers and social scientists [1, 2]. The deviation in altitude, temperature, rainfall, soil type and ecological situations leads to the need of a wide range of varieties which may not be provided by the current breeding program [4]. There is a case in which variability of farmer's preference and limited success of breeding programs resulted due to environmental variation [5, 17]. Specially for most of the highland pulses including field pea in Ethiopia, crop improvement only pursuing the Meher season, when rainfall is abundant that is the reason for missing some farmers preference traits like drought resistance and others. In similar to this truth, there is a tendency of breeders does not prioritize important traits for marginal environments [6]. In addition limited seed supply and dissemination system were also pointers poor adoption of the new varieties. Kindly knowing farmers' inclinations across different agro-ecologies and growing seasons is a prior step for breeding programs that pursue to develop conventional varieties by farmers [5]. Preferably the breeding program should work openly thru agriculturalists (both genders) in variety selection, co-operatively valuing new varieties beside with farmers existing local varieties. Involving both gender groups, in each cropping systems, in which breeders identified important selection criteria in marginal environments, some of which differed by gender [5]. In Ethiopia, taking the concerns of both men and women is very important in field pea production and value chain involves gender specific roles. The existing variation among farmers' variety preferences from location to location helps breeder for easily understanding for future concern [5]. The right way for breeding system is communal working with all discipline in addition to farmers on field in participatory variety selection approach for setting prioritize order and target traits of importance. It also helps to ascertain and evaluate traits that are important to small scale farmer's especially subjective traits such as taste, aroma, color, seed size, market demand and other culinary qualities, which are difficult to measure quantitatively [2, 3]. Therefore, this study directed to finding traits that farmers consider more when selecting field pea varieties. The study focused on five location and main growing seasons in south eastern Arsi zone of Ethiopia, where the crop is widely grown. It also compares the difference in traits main concern among farmers and breeders in field pea variety selection.

# 2. Materials and Methods

### *2.1. Description of the Study Areas*

This trails were evaluated in 2016/2017 at four Woredas; Hexosa (Oda jila FTC), Digalu Tijo (Haro bilalo FTC), Munessa (Caffa FTC), Cholle (Akiya FTC) and Cholle (Amuma selam bar FTC) in which all locations are found in Arsi, south eastern Ethiopia. All locations were representing highland areas with variable soil type i.e. dark clay-loam, clay-loam, loam Clay loam and clay loam respectively. The trial was laid down in a single plot of 5m x 5m size. Each variety was planted in rows with spacing of 0.2m between rows and 1.5m between plots. DAP fertilizer was applied at the recommended rate of 100 kg/ha at sowing. Seed rate of 100 kg/ha was used.

Nine released field pea varieties comprising *Bursa, Letu, Bilalo, Adi, Burkitu, Gume, Markos* Megery, Tegegnech and one farmer cultivar (local check) was used for the study to seek farmer's preferences through participatory variety selection. Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet by researchers groups and farmers separately. Data like farmer preference on disease and pest's resistance, early maturity, drought tolerant, grain color, and yield data were collected through the prepared data collection sheet/record sheet by organizing mini field day and observation on farmer's field.

Invited participants were gathered at the host farmers' field to assess the field pea varieties at flowering stage, at maturity and at harvest, assisted by scientists, assistants from Kulumsa Research Center and agricultural experts from each Woredas. Out of the 117 participants at districts 31 were women (24.4%). At each stage of evaluation, farmers were asked to level the best and worst varieties, giving reasons in each case. Traits that were mentioned as the reason why farmers liked or disliked varieties were recorded. Then, traits were organized into lists and farmers asked to rank these traits on a scale of 1 ("less important") to 3 ("very important"). As a special criteria like test evaluation at fresh seed level which they seems directly proportional to the tests of Stew or locally 'Wot' after cooking were also seen. The associations of traits and varieties were computed based on farmers' ratings and agronomic data collected from the field experiment. Traits identified as important by PVS were compared to current targets of the national field pea variety selection program (Table 4). Target traits of the national field pea variety selection program were obtained from the Ethiopian Institutes of agricultural research crop directorate. Finally participant farmers were also asked to give an overall score to each variety.

***Table 1.*** *Lists of faba bean varieties.*

| Variety | Year of release (G. C) | Days to maturity | Seed size (gm) | Character | Altitude | Adaptation eminence |
|---|---|---|---|---|---|---|
| Bursa | 2015 | 134-157 | 189 | Shiro-type | 1900-3000 | Nationally released |
| Letu | 2010 | 130-165 | 178 | Shiro-type | 1800-3000 | Nationally released |
| Bilalo | 2012 | 118-170 | 224 | Kick-type | 1900-3000 | Nationally released |
| Adi | 1995 | 120-150 | 209 | Kick-type | 2300-3000 | Nationally released |
| Burkitu | 2009 | 110-160 | 208 | Kick-type | 1800-3000 | Nationally released |
| Gume | 2006 | 100-149 | 201 | Kick-type | 1800-3000 | Nationally released |
| Tegegnech | 1994 | 120-150 | 215 | Shiro-type | 2000-3000 | Nationally released |
| Megery | 2006 | 95-150 | 136 | Shiro-type | 2300-3000 | Nationally released |
| Markos | 1995 | 120-130 | 188 | Kick-type | 1800-3000 | Nationally released |
| Local check | - | - | 129 | Shiro-type | 1800-3000 | Locally available |

### *2.2. Data Analysis*

Descriptive statistics and frequencies were calculated to identify the highest ranking traits. SAS-software was used for rank test for each location and gender group.

## 3. Results and Discussion

### *3.1. Farmers' Field Pea Variety Selection Criteria*

Records for fifteen traits those are important across five locations, one growing seasons and two gender groups were detailed in (Table 2). Seven of these traits are agronomic, five reflect biotic and abiotic stress tolerance, and three are related to utilization and marketability. Farmers are clearly considering many traits when choosing which field pea variety to grow. This is consistent with several other studies, in other crops (maize, Potato and sorghum), which stressed that small farmers consider multiple traits for variety selection [3, 5, 18, 14]. It is also reliable with the reflection that the majority of field pea producer farmers in Ethiopia grow more than one variety as one variety rarely meets all needs.

### *3.2. The Relative Importance of the Farmers' (Each Gender Group) Variety Selection Traits*

All considered relative importance traits are rated in each agro-ecology by using a 1 to 3 scale (1=less important, 2=somewhat important, 3=very important). Accordingly, the mean rate values revealed as, more than 60% of the farmers across all location preferences considered nine traits as a ''very important''(table 2). Two of the nine were biotic and abiotic tolerance traits-Powdery mildew and drought tolerance. Four of the nine were agronomic traits- yield, pod per plant, seed per pod and early maturity date. All traits related to utilization is a very special behind the farmers'– suitability for boiling, stew, and market demand - were considered "very important" by farmers in all locations. So it is very difficult to do adoption for new field pea varieties that lack any of these traits.

***Table 2.*** *Average ranks of field pea variety based on trait importance by location/district and gender.*

| Traits | FTC-1 | | | FTC-2 | | | FTC-3 | | | FTC-4 | | | FTC-5 | | | Location Mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Rank | Male | Female | Rank | Male | Female | Rank | Male | Female | Rank | Male | Female | Rank | Male | Female | Rank |
| Biotic and abiotic tolerance | | | | | | | | | | | | | | | | | | |
| DT | 2.6 | 2.2 | 3 | 2.3 | 2.4 | 4 | 2.5 | 2.5 | 2 | 2.5 | 2.6 | 2 | 2.3 | 2.2 | 4 | 2.44 | 2.38 | 2 |
| LFA | 2.3 | 2 | 5 | 2.5 | 2.3 | 3 | 2.4 | 2.5 | 3 | 2.0 | 2.2 | 4 | 2.6 | 2.5 | 2 | 2.36 | 2.3 | 3 |
| AB | 2.9 | 2.6 | 1 | 2.1 | 2 | 5 | 2.1 | 2.2 | 4 | 2.4 | 2.3 | 3 | 2.4 | 2.2 | 3 | 2.38 | 2.26 | 4 |
| PW | 3 | 2.5 | 2 | 2.7 | 2.6 | 1 | 2.6 | 2.4 | 1 | 2.9 | 2.5 | 1 | 2.8 | 2.7 | 1 | 2.8 | 2.54 | 1 |
| A | 2.4 | 2.4 | 4 | 2.8 | 2.5 | 2 | 2.1 | 1.7 | 5 | 1.6 | 1.4 | 5 | 1.9 | 2.1 | 5 | 2.16 | 2.02 | 5 |
| Agronomic Traits | | | | | | | | | | | | | | | | | | |
| EFD | 2.6 | 2.4 | 6 | 2.5 | 2.4 | 7 | 2.6 | 2.7 | 5 | 2.7 | 2.3 | 5 | 2.3 | 2.6 | 7 | 2.54 | 2.48 | 6 |
| EMD | 2.9 | 2.8 | 5 | 2.6 | 2.5 | 5 | 2.6 | 2.6 | 6 | 2.7 | 2.5 | 4 | 2.7 | 2.2 | 6 | 2.7 | 2.52 | 5 |
| PH | 2.3 | 2.1 | 7 | 2.5 | 2.0 | 6 | 2.8 | 2.1 | 7 | 2.3 | 2.2 | 7 | 2.7 | 2.8 | 5 | 2.51 | 2.24 | 7 |
| SPP | 3 | 2.9 | 3 | 2.8 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2.96 | 2.98 | 3 |
| PPPL | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 2.9 | 1 | 3 | 3 | 2 | 3 | 2.99 | 2 |
| SS | 2.8 | 2.9 | 4 | 2.7 | 2.6 | 4 | 3 | 2.5 | 4 | 2.5 | 2.6 | 6 | 3 | 2.7 | 4 | 2.8 | 2.66 | 4 |
| YLD | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 1 |
| Utilization | | | | | | | | | | | | | | | | | | |
| SFB | 2.1 | 2.9 | 3 | 2.3 | 2.8 | 3 | 2.2 | 2.7 | 3 | 2.3 | 2.9 | 3 | 2.5 | 2.8 | 3 | 2.28 | 2.82 | 3 |
| SFS | 2.8 | 3 | 1 | 3 | 3 | 1 | 2.7 | 2.8 | 2 | 2.7 | 2.9 | 1 | 2.5 | 2.9 | 1 | 2.74 | 2.92 | 1 |
| MD | 2.6 | 2.8 | 2 | 2.7 | 3 | 2 | 2.5 | 3 | 1 | 2.9 | 2.8 | 2 | 2.4 | 2.9 | 2 | 2.62 | 2.9 | 2 |

FTC-1, 2, 3, 4, 5 is representing Oda jila, Haro bilalo, Chafa, Akiya and Amuma salam bar kebeles. Ratings are on a scale of 1 to 3, where 1 is less important and 3 is very important which also indicated the ranks of the traits. Traits: DT; drought tolerance, LFA; low fertility adoption, AB; ascochyta blight, PW; powdery mildew, A; aphid, EFD; early flowering date, EMD; early maturity date, PH; plant hight, SPP; seed per pod, PPPL; pod per plant, SS; seed size, YLD; yield, SFB; suitability for boiling, SFS; suitability for stew and MD; market demand.

For the remaining traits there is an opportunity of deliberated as a very important by only a few farmers or was allied to other traits of importance in each location. Low fertility adoption from biotic and abiotic tolerance is considered ''very important'' behind a specific farmers at some location because of less capacity to afford chemical fertilizers cost. Aphid was also considered as a "very important" for farmers at some location especially those have low moisture that favors the occurrence of aphids. Among agronomic traits early flowering which is correlated with early maturity were significant traits on behalf of breeders looking for to develop new varieties for off season production, but majority of the farmers did not consider the traits as a "very important" since they are more adopted to grow the varieties depending on when the rain starts [13]. There is a possibility of farmers using late and early maturing varieties based on set of the rain. Plant height for high biomass content that could be used as an animal feed was considered as a "very important" behind individual farmers for some location.

### *3.3. How Location Influences Field Pea Variety Selection*

This study revealed the agro-ecological and cropping season difference has a huge impact on farmers' variety selections for at least some traits (Table 2). Drought tolerance, adaptation to low soil fertility, and ascochyta blight and aphids were among the abiotic and biotic stress tolerance traits those are varied in values of rating rank between agro ecological zones. From (table 2) above, location represented by FTC-3 and FTC-4 (sub-moist agro ecology) showed as drought is more severe than the rest location those are mostly moist agro ecology. At locations (FTC-2, FTC-3 and FTC-5) low fertility adaptation is considered more important. The importance of agronomic traits was also showed a little bit variation between agro ecologies (Table 2). But majority of the traits importance are similar rate value rank across location that might be resulted due to the communal interests of farmers on the considered traits importance. For such situation, breeders can easily meet the interests of all farmers living in different agro ecologies at once through improving the considered ''very important traits". There is no difference among the relative importance of utilization traits; - suitability for boiling, suitability for stews and market demand due to agro ecologies (Table 2). This confirms that all farmers of each location have a common utilization system of field pea crops i.e. suitability for stew (stable food) makes more sounded crop in Ethiopia.

### *3.4. How Gender Influences Field Pea Variety Selection*

Farmers were segregated into gender groups during the process of the PVS experiment to identify important traits at different field pea growth stages. For the biotic and abiotic tolerance traits male group were more concerned than female group in each location and on each trait as shown in rated scale values in table 2. For all agronomic traits, both gender groups showed almost comparable rating scale values that might be resulted due the common national interests of all farmers on the considered traits. Irrespective of this, female groups were more concerned on rate scale values for the utilization traits- suitability for boiling, suitability for stew and market demand than the men group in table 2. In overall this study revealed, the crop improvement like field pea needs gender inclusiveness for releasing the field pea variety that is nationally accepted with important traits.

***Table 3.*** *Association of local and new varieties with the 12 important variety traits studied under PVS.*

| Varieties | Low fertility adoption | Ascochyta blight | Powdery mildew | Early Maturity | Pod per plant | Seed per pod | Seed size | Seed color | Seed Shape | Soak ability | Suitability for stew | Market Demand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bursa | * | * | * | - | - | + | + | + | + | + | + | + |
| Letu | * | * | * | * | + | + | - | + | - | - | + | + |
| Bilalo | * | * | - | * | + | + | + | - | - | - | - | - |
| Adi | * | * | - | * | + | + | + | - | - | - | - | - |
| Burkitu | * | * | * | * | + | + | + | - | - | - | - | - |
| Gume | * | * | - | * | + | + | + | - | - | - | - | - |
| Tegegnech | * | * | * | - | - | - | - | + | + | - | + | + |
| Megery | * | * | * | * | - | - | - | - | - | - | * | - |
| Markos | * | * | * | * | + | + | - | - | - | - | - | - |
| Local check | + | - | + | + | * | * | * | + | + | + | + | + |

"+"=the variety and the trait are highly and positively associated; "*"=the variety and the trait are negatively associated and "-"the variety and the trait have intermediate preference. This is compiled from farmers' ratings and the agronomic data during the PVS experiment.

### *3.5. How Field Pea Varieties Are Preferred by Farmers*

During this PVS experiment, twelve characteristics of the varieties were evaluated below (Tables 3). But there are no varieties that fulfil the all of the traits farmers preferred. Similarly, it is impossible to find one variety that fulfills all of the characteristics farmers want [18, 12], since the convenience of varieties with different complements of traits allows farmers to satisfy their multiple needs is very scarce. There are many types of production risks for all crops in Ethiopia. On behalf of these challenges, a different author indicates, growing assorted set of varieties can reduce the risk of crop failure [15, 2]. This is more adopted in some areas of Ethiopia like Arsi zone where farmers grow more

than one variety of field peas. Twelve important traits were considered to evaluate field pea varieties below (Table 3). Of these varieties, entirely improved field pea varieties have mainly negatively associated to the traits like low fertility adoption, early maturity and ascochyta blight except the one which is used as local check have highly and positively associated to those traits at all location. In other side the entire improved field pea varieties have highly and positively associated for the traits pod per plant, seed per pod and seed size, than the local one which has negatively associated to the traits (table 3). Four of the nine improved varieties are equally accepted behind farmers for agronomic traits- pod per plant, seed per pod and seed size which has direct impact on production increment for food security system. 'Local check' and 'Bursa', a new variety, showed good performance for four and seven of 12 traits, respectively, in all agro ecologies. Comparably all improved varieties have an intermediate to highly important behind the farmers for all agronomic traits and utilization traits in all location. Despite of these field pea varieties especially shiro type (Bursa, Tegegnech, Latu and the local one has highly and positively associated for farmers for all utilization traits-soak ability, suitability to stew and market demand in all location. Since it has good taste when boiled, is suitable for stew, and the market acceptance of this variety by traders is higher than the kick type varieties. Moreover, 'local checks' is an early maturing and low fertility adoption variety at all location which is better adapted to off season production than the other varieties.

In views of this study revealed the trait importance dissimilarity among participatory variety selection (PVS) and current breeding objectives of the national field pea program. Twelve traits were very important for field pea variety selection by farmers in the PVS at all location per in at least one growing season. Nine traits were considered by national field pea breeding program (table 4) in main growing season only. Two traits were revealed less important by participatory variety selection farmers but no traits were considered as less important rather two traits considered as not important in current breeding program in a main season. In other side there is entire traits those are considered as somewhat important by participatory variety selection farmers and current breeding program in both cropping season. More over there is a traits those are considered as not important especially by current breeding program in main season (seed color and seed shape) off season (acidity tolerance, low fertility adoption, seed color, seed shape, soak ability, suitability for stew and market demand) in which the traits are considered at least somewhat important to very important traits behind the farmers at least in one season in all location.

The trait like "wide adaptation" was less important by farmers in the PVS experiment. In advance, in PVS the variation in number of traits considered is important and the national program was partially due to a difference in target seasons. In further, the tendency PVS experiment were questioned about both seasons while the current breeding program targets Meher season only with a specific traits those are not fulfils the farmers interest. However, this PVS experiment identified some traits those very important and common to the all agro-ecological zones but currently not given as a priority traits in breeding program. Some of the new varieties fall apart when cooked and are not suitable for stew especially the kick type not as good as the shiro one by the farmers. In fact there is a report that some quality traits can be a challenge for breeders to profoundly evaluate without they cooperate carefully per farmers [2]. In overall this PVS experiment was designed to ascertain traits of prominence in diverse location/agro ecologies. So the virtual significance of diverse traits in altered localities was resulted by the causes of PVS. Insight of this, it is better if national field pea breeding program follow to develop varieties for vague agro-ecologies than specific agro-ecology.

***Table 4.*** *The variation of traits importance among Participatory Variety Selection (PVS) and the national field pea breeding program in Ethiopia.*

| **Traits** | **Participatory variety selection** | | **Present-day breeding program** | |
|---|---|---|---|---|
| **Cropping season** | **Main season** | **Off season** | **Main season** | **Off season** |
| Biotic and Abiotic tolerance | | | | |
| Acidity Tolerance | * | | ** | NI |
| Low fertility adoption | ** | | ** | NI |
| Ascokayta blight | *** | | *** | ** |
| Powdery mildew | *** | | *** | ** |
| Agronomic Traits | | | | |
| Early Maturity | *** | Depends on rain fall distribution | *** | *** |
| Pod per plant | *** | | *** | *** |
| Seed per pod | *** | | *** | *** |
| Seed size | ** | | *** | ** |
| Seed color | ** | | NI | NI |
| Seed shape | * | | NI | NI |
| Yield | *** | | *** | *** |
| Utilization | | | | |
| Soak ability | *** | | ** | NI |
| Suitability for stew | *** | | *** | NI |
| Market demand | *** | | *** | NI |

"+"=highly and positively associated; "*"=negatively associated and "-"intermediate preference.

# 4. Conclusion

This study exposed the diverse farmers' variety selection criterion that helps them to fulfill their multiple needs. They are more focuses on biotic and abiotic tolerance traits, agronomic traits and in utilization aspects especially the exceedingly worth qualities like food value, long term storability, resistance to biotic stresses such as powdery mildew, ascochyta blight, Aphid. Based on this study result, location/agro ecology, cropping seasons, and genders have a lion share on farmers' selection criteria variation. In further, the traits that are considered by farmers at one location may not be similarly getting consideration at other location and cropping season. There is also the variety selection criteria difference for a few but not most traits among the gender group. Hence it is impossible to fulfil all farmers' needs without participatory variety selection approach in developing a new variety. This research also concludes that the being of distinctive and vital traits in local check varieties that is not existent in improved varieties, and these traits have not yet received attention by the national field pea breeding program. Further, the erratic needs resultant from variances between location, cropping seasons and gender should also be well-thought-out during variety selection. Similar research could also be undertaken in Arsi zones to better add values on the guidance of national field pea breeding program.

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